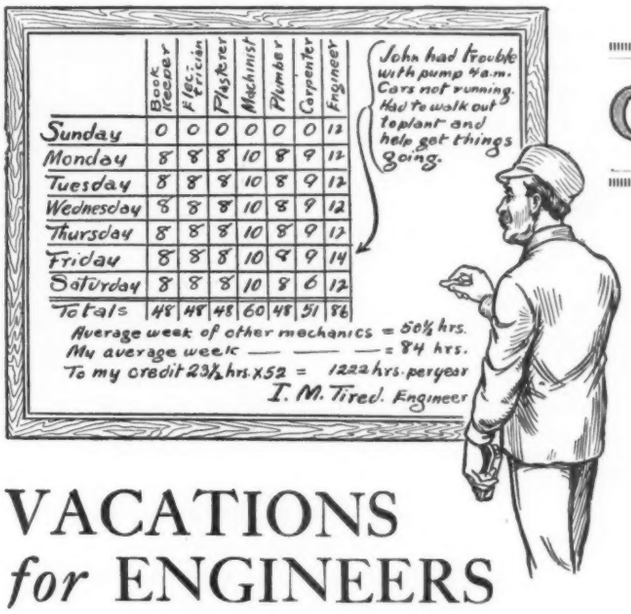
POWER

Vol. 42 NEW YORK, JULY 13, 1915 No. 2

Candid Chats


Book Keeper
Elec. Fricia
Plasterer
Machinist
Plumber
Carpenter
Engineer
Sunday 0 0 0 0 0 0 12
Monday 8 8 8 10 8 9 12
Tuesday 8 8 8 10 8 9 12
Wednesday 8 8 8 10 8 9 12
Thursday 8 8 8 10 8 9 12
Friday 8 8 8 10 8 9 14
Saturday 8 8 8 10 8 6 12
Totals 48 48 48 60 48 51 86
John had trouble with pump 4 a.m. Cars not running. Had to walk out to plant and help get things going.
Average week of other mechanics = 50½ hrs.
My average week —— —— —— = 84 hrs.
To my credit 33½ hrs. X 52 = 1222 hrs. per year
I. M. Tired. Engineer

VACATIONS *for* ENGINEERS

This is the time of the year when men naturally think of rest and recreation. The druggist, the grocer, the mill owner and his superintendent hie themselves off to some cool mountain resort or to the seashore and fish to their heart's content. Uncle Sam's employees usually get at least two weeks each year at full pay, for recreation.

As it is with these, so we find it in the various walks of life, but how few engineers are fortunate enough to get even a few days for a much needed rest. Look back over the last year and count how many days you have been absent from your plant, also how many times you have been called out at night.

We believe that if "Power" had a record of all of its readers, it could not be equaled by any group of workers in the world for steadiness and industry. The engineer is steady and industrious or he never could have been an engineer.

We are taught that to develop muscles we must give them exercise in increasing quantities each day. The man that can lift a three hundred-pound weight could not do it before he trained to do it. And so it is with the mind. Few engineers could have held the positions four or five years ago that they hold today; but muscles will tire and brains will fag unless they have the proper rest. Therefore, if it is in any way possible, take a few days off and at least get acquainted with your wife and little ones.

Probably a substitute would not run things so smoothly as you yourself, but he could get along and the engines would not be "impaired" so much as you will be "repaired."

If you figure it up you will find that you have a goodly number of hours to your credit over and above the time worked by most men. Surely, those who work twelve hours per day seven days per week are entitled to relief for awhile from the daily grind.

Throw away the alarm clock for a few days, visit, get your mind into new channels for a spell and when you come back to work you will go at it with new interest and new vim.

[Contributed by Earl Pagett, Coffeyville, Kan.]

Savage Manufacturing Co.'s Power Plant, Savage, Md.

By W. O. Rogers

SYNOPSIS—A combination hydro-electric and steam-turbine generating plant for mill operation. Vertical boilers generate steam at 180 lb. pressure, which is superheated naturally approximately 30 deg. The turbine is guaranteed to operate with a steam consumption of 20 lb. per kilowatt-hour. The piping arrangement is simple and is placed between the boilers and the wall separating the boiler and turbine rooms, where it is out of the way, although easy to get at.

The new turbine power plant of the Savage (Md.) Manufacturing Co. has just been completed, and put into operation. It is of interest, not because of its large size, but by reason of the unusual combination of generating units.

The mill, which manufactures cotton goods, was originally belt-driven by a 20x48-in., 225-hp. Corliss engine, and an old type of waterwheel of 750-hp. capacity. There was also 375 hp. in boiler capacity. The mill mechanical

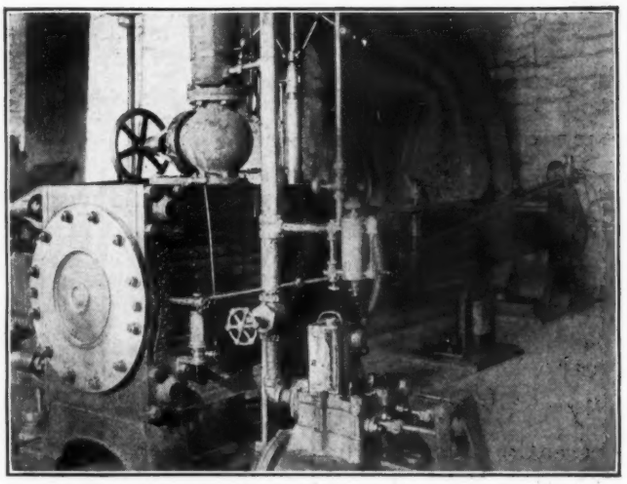


FIG. 3. OLD CORLISS WHICH THE TURBINE DISPLACED

drives, in several instances, were of right-angled turns, which have been replaced with induction-motor group drives. In most cases the motors are of comparatively large size. It is expected that motor drives will be used in a considerable part of the mill.

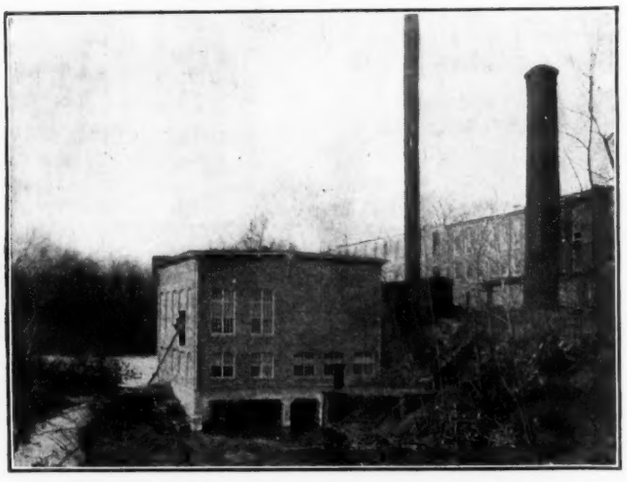


FIG. 1. POWER PLANT BUILT OUT OVER THE RIVER

The new power plant, Fig. 1, is constructed over the Patuxent River, and a heavily reinforced concrete floor is used. The building is of brick, 55 ft. long and 60 ft. wide; the boiler room is 30 ft. 6 in. wide and a 2-ft. partition wall separates it from the turbine room, which is 27 ft. 6 in. wide. The boiler-room floor is level with the turbine-room basement. The 600-kw. turbo-generator rests on a floor which occupies about one-half of the turbine room and elevates the turbine 12 ft. above the basement floor. With this construction the basement is left free for auxiliary units, as there are no foundations and no piers with the exception of one small one which supports the anchor elbow of the 24-in. exhaust pipe of the turbine.

Current is generated at 600 volts, 60-cycle, at 3600 r.p.m. The guarantee of the turbine at full load, with

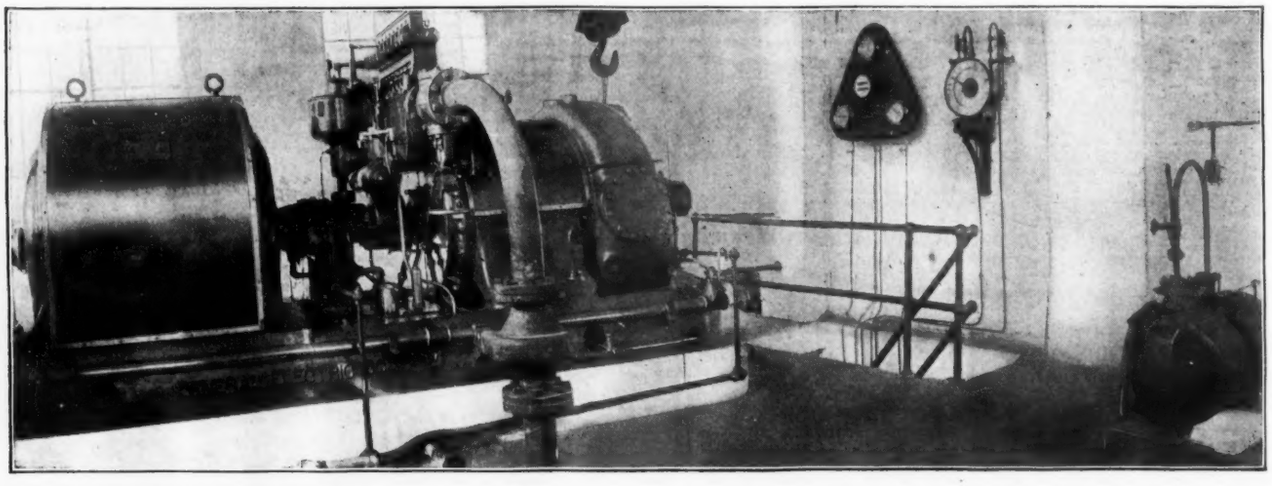


FIG. 2. PARTIAL VIEW OF THE TURBINE ROOM. ONE OF THE EXCITERS IS SHOWN AT THE RIGHT

3-in. absolute back pressure and 175 lb. of dry steam, is 20 lb. per kilowatt-hour.

There are two 7-kw., 125-volt exciters; one is turbine-driven at 1500 r.p.m., the other motor-driven at 1800 r.p.m. These units are at one side of the turbine room, a partial view of which is shown in Fig. 2. On the opposite side of the room is a three-panel switchboard; one panel being for the generator and the other two for the exciter units.

Connected in the steam line to the turbine is a steam-flow meter which records the pounds of steam per hour being used by that unit.

Exhaust steam from the turbine is condensed in a No. 20 barometric condenser that is guaranteed to condense 15,000 lb. of steam per hour with injection water at 80-deg. temperature, and to maintain a vacuum of 27 in. referred to 30-in. barometer. The condenser is on the outside end of the building, as shown in Fig. 5, which is a side elevation of the turbine room.

Injection water for the condenser is supplied by a 16x20x24-in. horizontal, simplex steam pump of sufficient

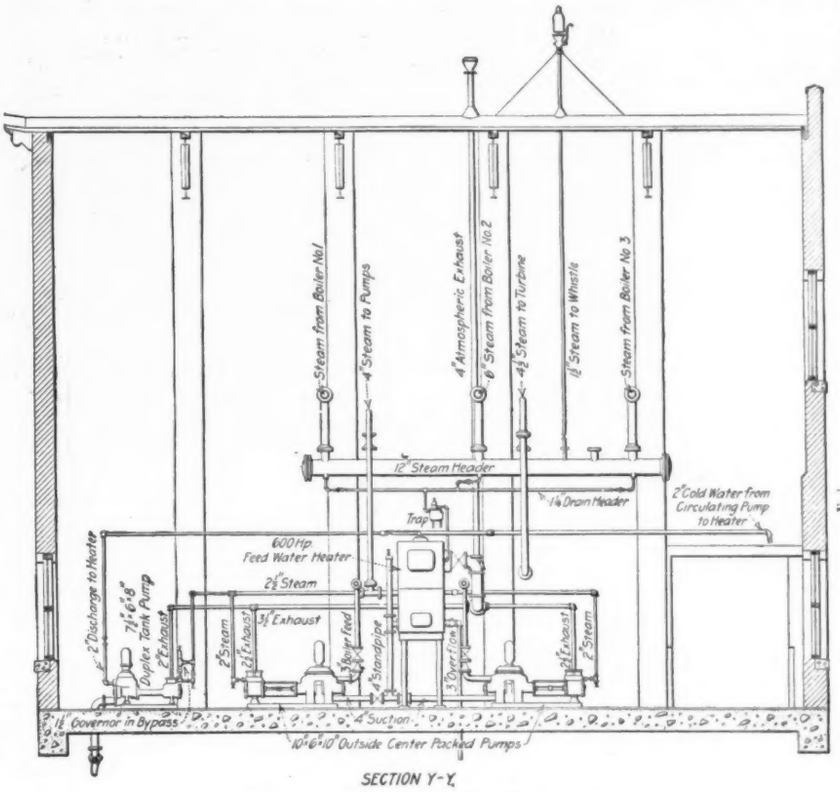


FIG. 4. PUMP AND HEATER PIPIN

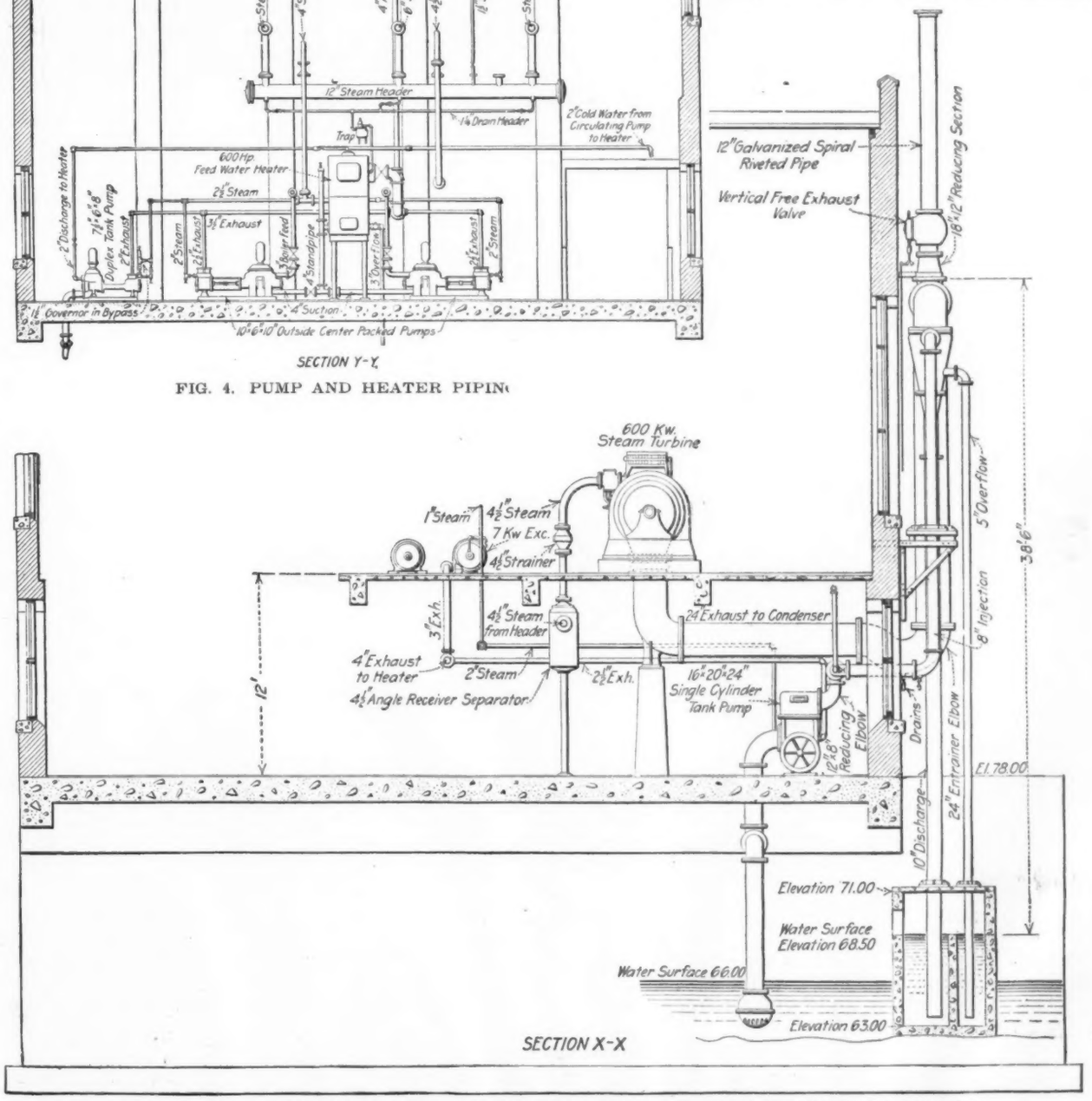


FIG. 5. SIDE ELEVATION OF THE TURBINE ROOM SHOWING THE ARRANGEMENT OF THE PIPING AND OF THE CONDENSER

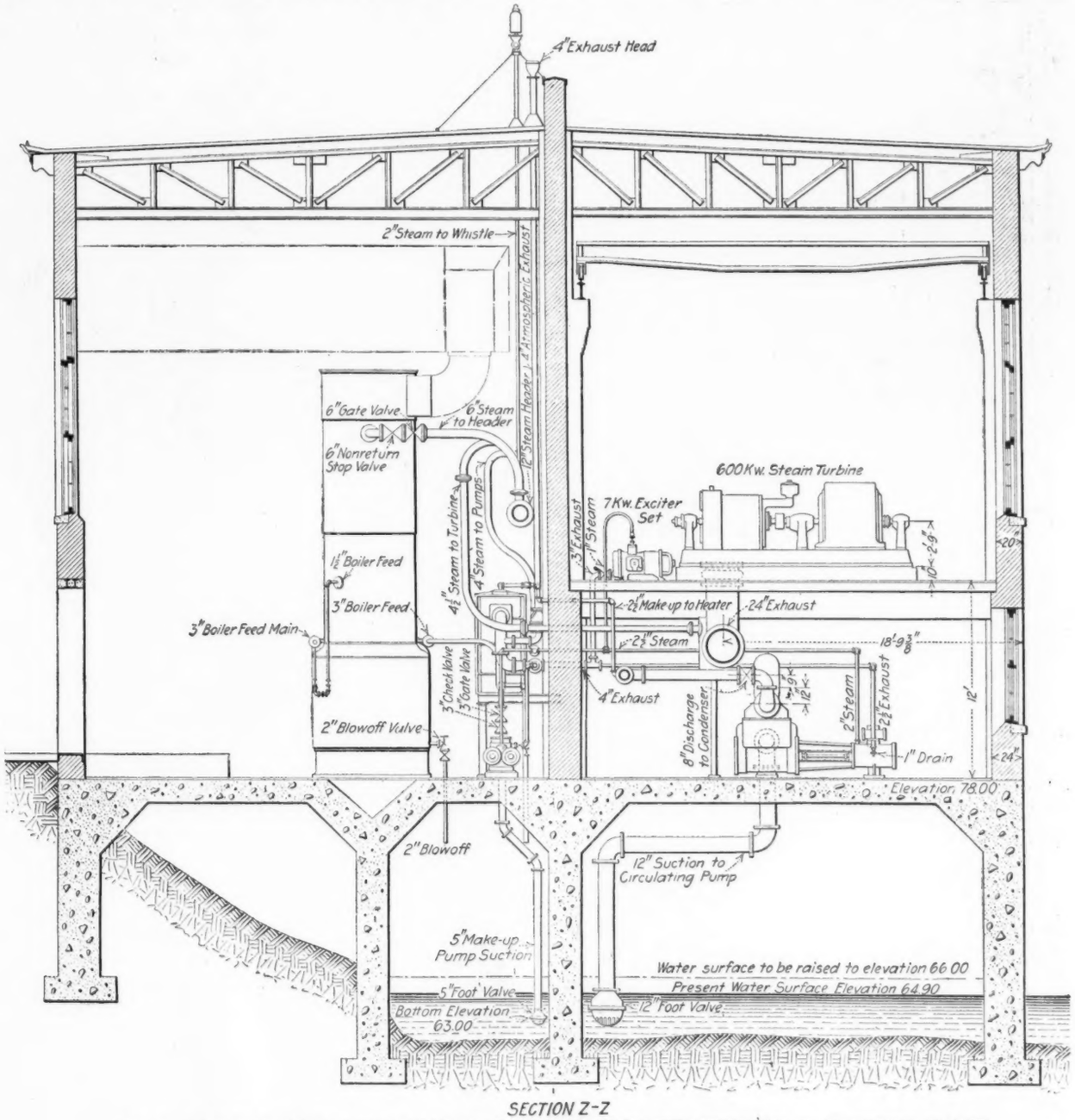
capacity to handle the required amount of water at 24 r.p.m. This pump is in the basement and the condensing water is pumped from the river through a 12-in. suction pipe with a 15-ft. lift at ordinary water levels. This is shown in the end elevation of the plant, Fig. 6.

There is space for a duplicate installation of generator and condensing apparatus should it ever become advisable to install the same.

The boiler room has three vertical fire-tube boilers, Fig. 7, each of 183.4 nominal horsepower, and built for 200 lb. pressure. The smoke flue from each boiler connects to a main smoke flue, which runs to a 125-ft. high self-supporting steel stack 5 ft. in diameter. The water-heating surface of each boiler is 1647 sq.ft., with 554 sq.ft. of superheating surface. There are 232 tubes 2½ in. in diameter and 15 ft. long in each boiler. The grate surface per boiler is 33.1 sq.ft. The total of 550.2 boiler horsepower gives one horsepower to 1.09 kw. of generator capacity. In grate area there is 1 sq.ft. per 5.54 boiler horsepower; 1 sq.ft. for each 4.97 sq.ft. of water-heating surface and 1 sq.ft. per 6.65 sq.ft. of combined boiler heating and superheating surface.

A pressure of 180 lb. is carried with approximately 30 deg. of natural superheat. The furnaces are hand-fired, and coal is taken from a concrete pocket extended from a coal trestle to the side doors of the boiler room.

With the exception of the injection-water pump, all pumps are at the back of the boilers, next to the partition wall, Figs. 6 and 9, the latter being a plan view of the plant. There are two 10x6x10-in. horizontal, outside center-packed duplex pumps designed to operate against 200 lb. pressure. Makeup water is supplied by a 7½x6x8-in. duplex pump designed to operate against a pressure of 75 lb. It is controlled by a pump governor and is used for supplying makeup water to a 600-hp. open feed-water heater. This heater is supported on a



SECTION Z-Z

FIG. 6. END SECTIONAL ELEVATION OF THE SAVAGE MANUFACTURING CO.'S POWER PLANT

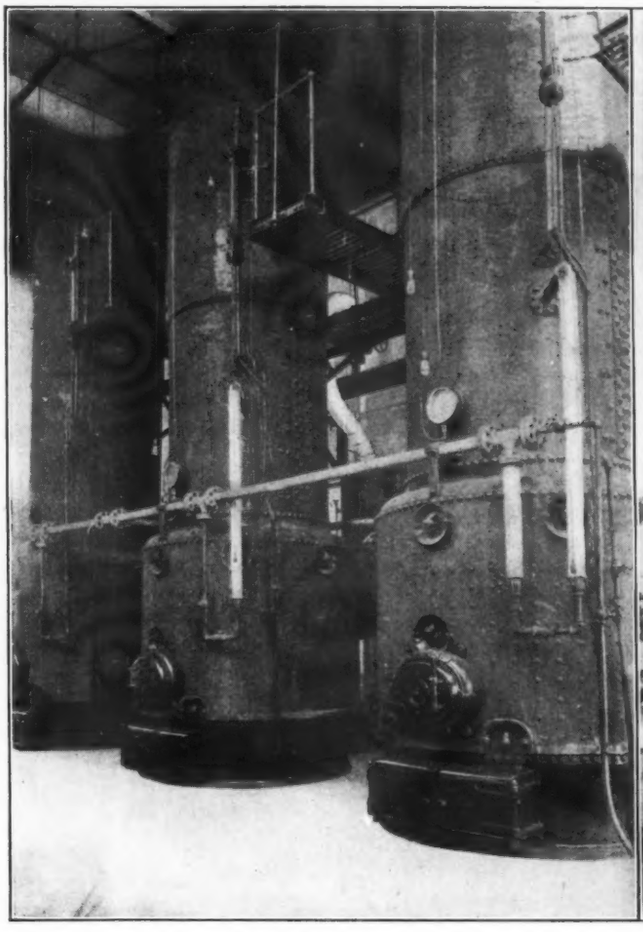


FIG. 7. THE THREE VERTICAL BOILERS

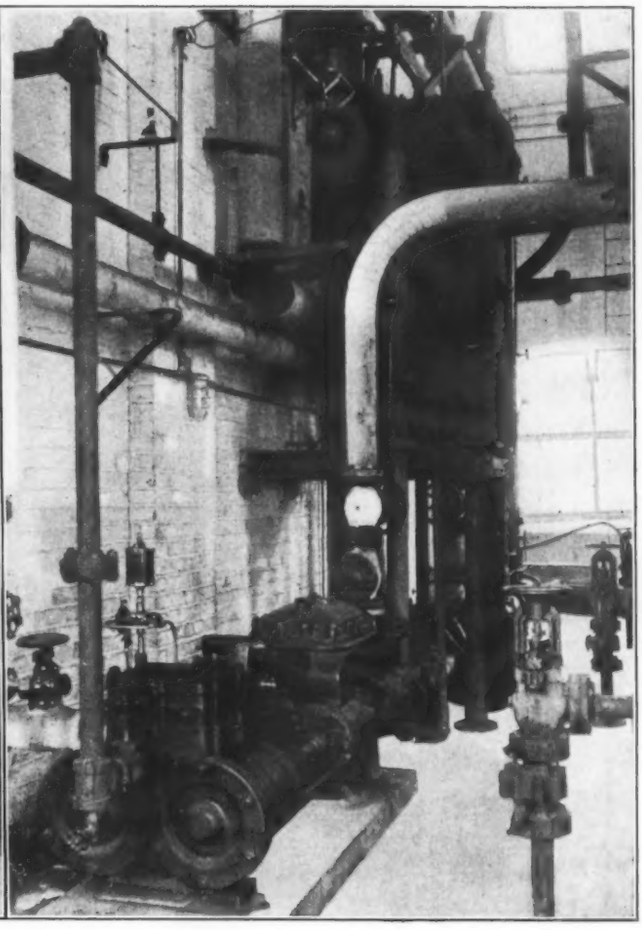


FIG. 8. PUMPS AND HEATER BACK OF THE BOILERS

platform at the back of the boiler and between the two feed pumps. It is guaranteed to deliver feed water at a temperature within 2 to 5 deg. F. of that of the exhaust steam entering it from the auxiliary units.

The piping carrying live steam is made of full-weight steel pipe with high, hot-rolled steel flanges. The steam leads from the boilers are fitted with nonreturn stop valves. All high-pressure drips are carried back to the heater by means of traps. All high-pressure steam pipes are conveyed by 85-per cent. magnesia of double thickness, and single thickness on the exhaust lines.

The boilers are connected to the 12-in. header by 6-in. pipes bent to a 3-ft. radius. All connections to the header are made at the top, excepting three outlets to the 1¼-in. drain header, which drains the water of condensation to a trap, which in turn discharges it to the heater. Details of the header and pump piping are shown in Fig. 4. In order to keep all piping out of the turbine room the 4½-in. line to the turbine is taken from the header toward the boilers at a 21-in. radius bend, and dropping to a point below the turbine-floor level, runs at a right angle to the 21-in. diameter steam receiver separator, which is also below the floor line, the only piping in the turbine room being that which extends vertically from the receiver separator to the automatic throttle valve on the turbine.

PRINCIPAL EQUIPMENT OF SAVAGE MANUFACTURING CO.'S POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Turbo-generator	4-stage horizontal	600-kw.	Main unit	180 lb. steam, 30 deg. superheat, 600 volts, 60-cycle, 3600 r.p.m.	General Electric Co.
3	Boilers	Vertical, Manning	183-hp.	Steam generators	180 lb. steam, 30 deg. superheat, hand-fired	D. M. Dillon Steam Boiler Wks.
1	Condenser	Barometric	No. 20	With main turbine	27-in. vacuum, capacity 15,000 lb. steam per hr.	Buffalo Steam Pump Co.
1	Motor	Induction	7-kw.	Driving exciter generator	600 volts, 3-phase, 60-cycle, 1800 r.p.m.	General Electric Co.
1	Turbine	Single-stage	7-kw.	Driving exciter generator	1500 r.p.m., 180 lb. steam	General Electric Co.
1	Generator	Direct-current	7-kw.	Exciter generator	Motor-driven, 1800 r.p.m.	General Electric Co.
1	Generator	Direct-current	7-kw.	Exciter generator	Turbine-driven, 1500 r.p.m.	General Electric Co.
1	Pump	Duplex	7½x6x8-in.	Makeup water	180 lb. steam, automatic controlled	Buffalo Steam Pump Co.
1	Pump	Simplex	16x20x24-in.	Injection water	180 lb. steam	Buffalo Steam Pump Co.
2	Pumps	Duplex, outside-packed	10x6x10-in.	Boiler feed	180 lb. steam	Buffalo Steam Pump Co.
1	Meter	Steam flow		With main turbine	Records lb. steam per hour	General Electric Co.
1	Heater	Open, Webster	600-hp.	Heating feed water	Heats water to temperature of 2 to 5 deg. of that of exhaust steam	Warren Webster & Co.
1	Stack	Steel	125 ft. high, 5 ft. dia.	Flue gases	Natural draft	Walsh & Weidner Co.
1	Regulator	Fisher		On makeup pump	Steam and water actuated	Fisher Governor Co.
4	Pumps	Oil	1-pt.	On pumps	Driven by pump action	Lunkenheimer Co.
1	Crane	Traveling	10-ton	Turbine room	Hand operated	Whiting Foundry Equipment Co.
1	Trap	Vacuum		With condenser	Automatic	Strong, Carlisle & Hammond Co.
1	Trap	Return		With drip	Automatic	C. & E. Squires Co.
2	Water-wheels	Double	24-in.	Driving 750-kw. generator	With 49 ft. head	S. Morgan Smith Co.
1	Generator	Alternating-current	750-kw.	Main unit	Waterwheel driven	General Electric Co.

Most of the piping in the plant is at the rear of the boilers, out of the way and at the same time easy to get at. A 4-in. pipe drops from the main header to a 3½-in. auxiliary header, which reduces at both ends to 1½-in. for the makeup pump. The exhaust connection runs to a 3½-in. header connecting to the heater. A 4-in. atmospheric exhaust is provided from the heater connection.

A standpipe is provided for the 4-in. suction pipe, which drops to the floor level and branches to the two feed

The new plant supplants three water-tube boilers, and a 20x48-in. Corliss engine (Fig. 3). The old inefficient 750-hp. waterwheel has been replaced by two sets of waterwheels and generators. One set has a rating of 750 kw., and is used during normal running hours of the mill at such times as sufficient water is available. The other set has a rated output of 125 kw.; it is used for overtime work, and for running in parallel with the steam power plant at times of comparatively low water. The

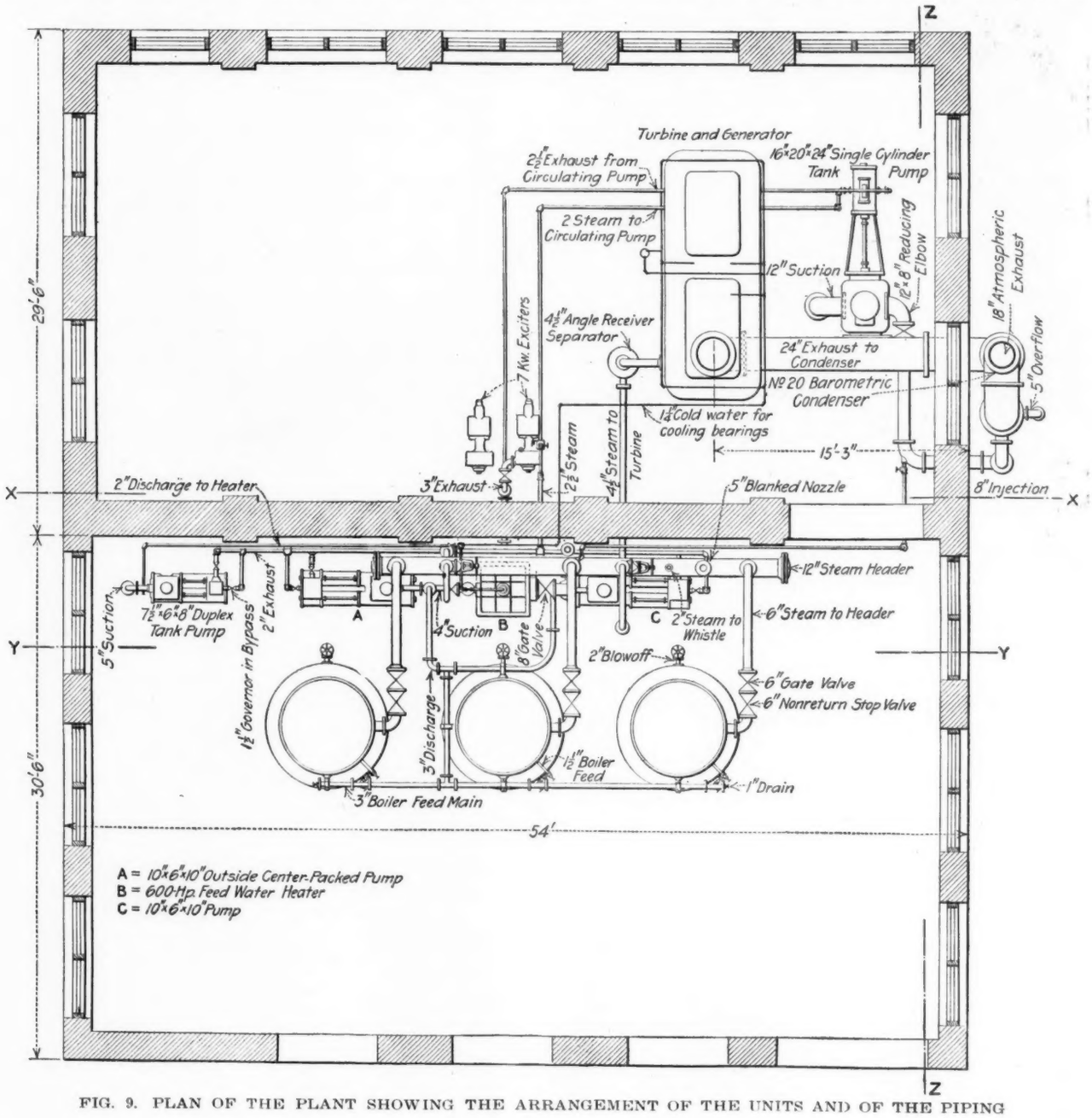


FIG. 9. PLAN OF THE PLANT SHOWING THE ARRANGEMENT OF THE UNITS AND OF THE PIPING

pumps. The makeup pump obtains water from the river through a 5-in. suction and discharges through a 2-in. line to the heater. An extension of this line runs to the circulating pump, thus providing two sources of makeup water.

A 2-in. steam line runs to the injection-water pump, which exhausts through a 2½-in. line to the exhaust header. The water end discharges through an 8-in. line to the condenser.

speed of each set of waterwheels is governed by waterwheel governors. The main distributing switchboard for the turbine and waterwheel generators is on a gallery in the hydro-electric plant, which simplifies the switchboard arrangement in the turbine room.

The combination of hydro-electric and steam power with vertical boilers and low superheated steam is unusual, and as the apparatus is of the latest design, the cost of generating power should be materially less than

under old conditions. The accompanying test figures show what can be expected for the steam plant under everyday operating conditions.

SUMMARY OF POWER-PLANT REPORTS, SAVAGE MANUFACTURING CO., SAVAGE, MD., FOR WEEK ENDING MAR. 13, 1915

Total gross kilowatt-hours by watthour meter	37,740
Plant kilowatt-hours for exciter set	442
Total net kilowatt-hours, plant output	37,298
Gross average kilowatts by indicating wattmeter	625
Plant average kilowatts for excitation	7.5
Net average kilowatts, plant output	617.5
Temperature injection water, deg. F.	41.0
Temperature discharge water, deg. F.	62.7
Temperature outside air, deg. F.	39.3
Temperature feed water, deg. F.	192.5
Vacuum inches, gage	28.15
Steam pressure, pounds by gage	175.7
Pounds of steam per hour by flow-meter	11,745
Pounds of coal burned per week	96,762
Net pounds of coal per kilowatt-hour, plant output, by watthour meter	2.59
Net pounds of steam per kilowatt-hour, plant output, by indicating wattmeter	19.02

Note—Coal consumed includes night and Sunday firing, but does not include heating and slashing of the mill, which was furnished from a separate boiler plant.

The plant was designed and installed by J. E. Sirrine, of Greenville, S. C. It is in charge of Chief Engineer James F. Frazier.

Beggs Automatic Sewage-Ejector System

Where natural flow and the self-cleansing of drainage pipes demand that liquid accumulations be collected at a level lower than that of the sewer into which they must be discharged, it is usually desirable to install and use an ejector system that will automatically expel such sewage. Such a system is illustrated herewith and is manufactured by James Beggs & Co., 36 Warren St., New York City.

The same system, with or without modification, may also be used for handling any liquids that can be accumulated in tanks, and which must be lifted to higher levels.

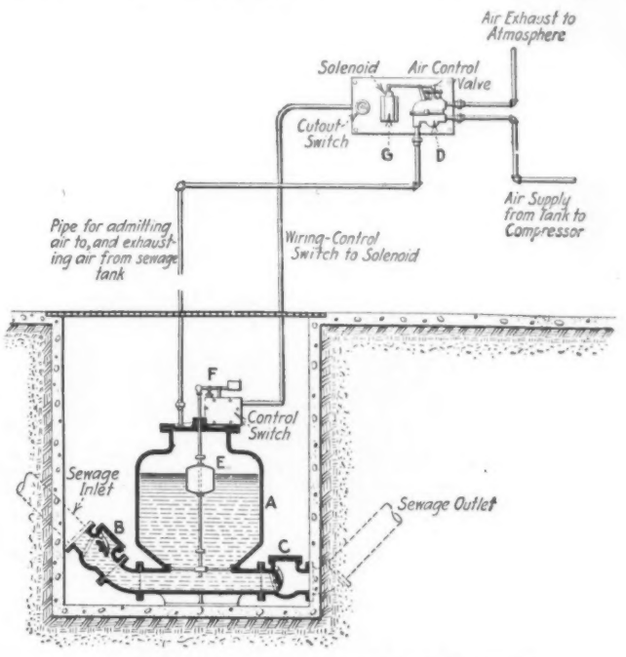
The device consists of a receiving tank *A* into which the sewage gravitates from the drain pipes, and which is designed to leave a space above the sewage into which compressed air is admitted for forcing the sewage, by displacement, through an outlet connected with the sewer. A check valve *B* in the tank inlet prevents the return of sewage into the drain pipes, and the valve *C* in the tank outlet prevents backing up of the sewage.

A special double-acting air valve *D*, electrically controlled, automatically admits enough compressed air each time to displace and expel the desired amount of liquid from the tank. The supply of compressed air may be taken from a general system or may be maintained by a suitable compressor and receiver installed to serve the ejector exclusively. One pipe connection between the valve *D* and the tank *A* alternately serves as an inlet for compressed air and an outlet for the exhaust of the air to the atmosphere after the sewage has been ejected and the tank is refilling.

A float *E*, rising and falling between stops according to the level of the liquid in the tank, automatically operates the control switch *F* mounted on the top of the tank. This switch opens and closes the electric circuit through a solenoid *G*, designed for any voltage which may be required to meet local conditions. It is mounted on the same base as the air-control valve and cutout switch for throwing the system in or out of operation.

The vertical rod connecting at its top to the switch lever, passes through the float. It is guided near its upper end by a stuffing-box in the cover of the tank and at its lower end by a suitable bearing, and is provided with two limiting stops.

The float, rising with the level of the liquid, strikes the upper stop and lifts the rod. This closes the switch and completes the electric circuit to the solenoid. The latter, through its plunger and lever, closes the upper



AUTOMATIC SEWAGE EJECTOR SYSTEM

valve, admitting compressed air for the discharge of the sewage. The float upon descending strikes the lower stop, carries the rod down, opens the control switch and breaks the circuit to the solenoid, thus permitting the spring to close the lower valve and open the upper one, which relieves the air pressure through the vent to the atmosphere. This completes the cycle, and sewage then collects for the next discharging operation.

How the Flow of a River Is Measured

If you see a man leaning over the railing of a bridge intently watching the river, with a telephone receiver at his ear do not think that he is trying to talk to the fishes or to a diver below the surface. He is probably one of the Government's engineers measuring the amount of water passing under the bridge. This is done by lowering an instrument, known as a current meter, into the water at several points under the bridge to determine the speed of the water and by measuring the depths of the water at the same points.

From such information the flow of the river at that particular time and height can be computed, and when such measurements have been made at a number of different heights the flow of t. stream at any height can be determined. Then, if a record of the height of the river is obtained each day from a river gage, the flow for each day can be computed. It was in this way that the information in "Water-Supply Paper 353" was obtained.—U. S. Geological Survey.

Massachusetts Is Awaking to the possibilities and importance of water-power conservation. The Harbor and Land Commission has asked for an appropriation of $25,000 for a thorough investigation of the possibilities of conserving, equalizing, and utilizing the flow of streams. The report emphasizes the need of codifying the water-power laws, and of formulating a water-power policy by the state, which at present is hampered by a divided control of streams by the Federal Government and various state commissions.

District Heating with Open Heater

By Thomas Wilson

SYNOPSIS—One of two district hot-water heating plants in the country employing an open heater. Advantages are absence of air in system, better heat transfer and less trouble from scale-forming ingredients in the water. Exhaust steam obtained from an electrical plant supplying current for light and power and the pumping of city water.

For thirty years Laporte, Ind., has had a privately owned electric plant. Naturally, it started in a small way and was added to from time to time as the load required. As all of the steam-driven equipment was operated non-condensing and with the machines then in vogue, the cost of producing current was high. In 1898 it was decided to install a hot-water heating system to serve both the business and the residential districts, and as the exhaust steam was utilized to heat the water, a more efficient combination was obtained. The heating system was one of the early Yaryan installations employing three closed heaters through which the water was forced by reciprocating pumps chain driven by high-speed engines. A great deal of trouble was experienced with the closed heaters. The water contained as high as 21 grains of incrusting solids per gallon, and if the heaters were allowed to go uncleaned for three months the tubes would fill up almost solid. As the scale in the tubes thickened the coefficient of heat transmission dropped until it was impossible to obtain the high water temperatures required in the colder weather. A back pressure of several pounds did not help much, and to make matters worse, air and gas collecting in the system were a source of constant annoyance. There were, of course, special valves through which the air might escape, but much of it had to be let out through the radiator cocks. This took time and the services of several troublemen.

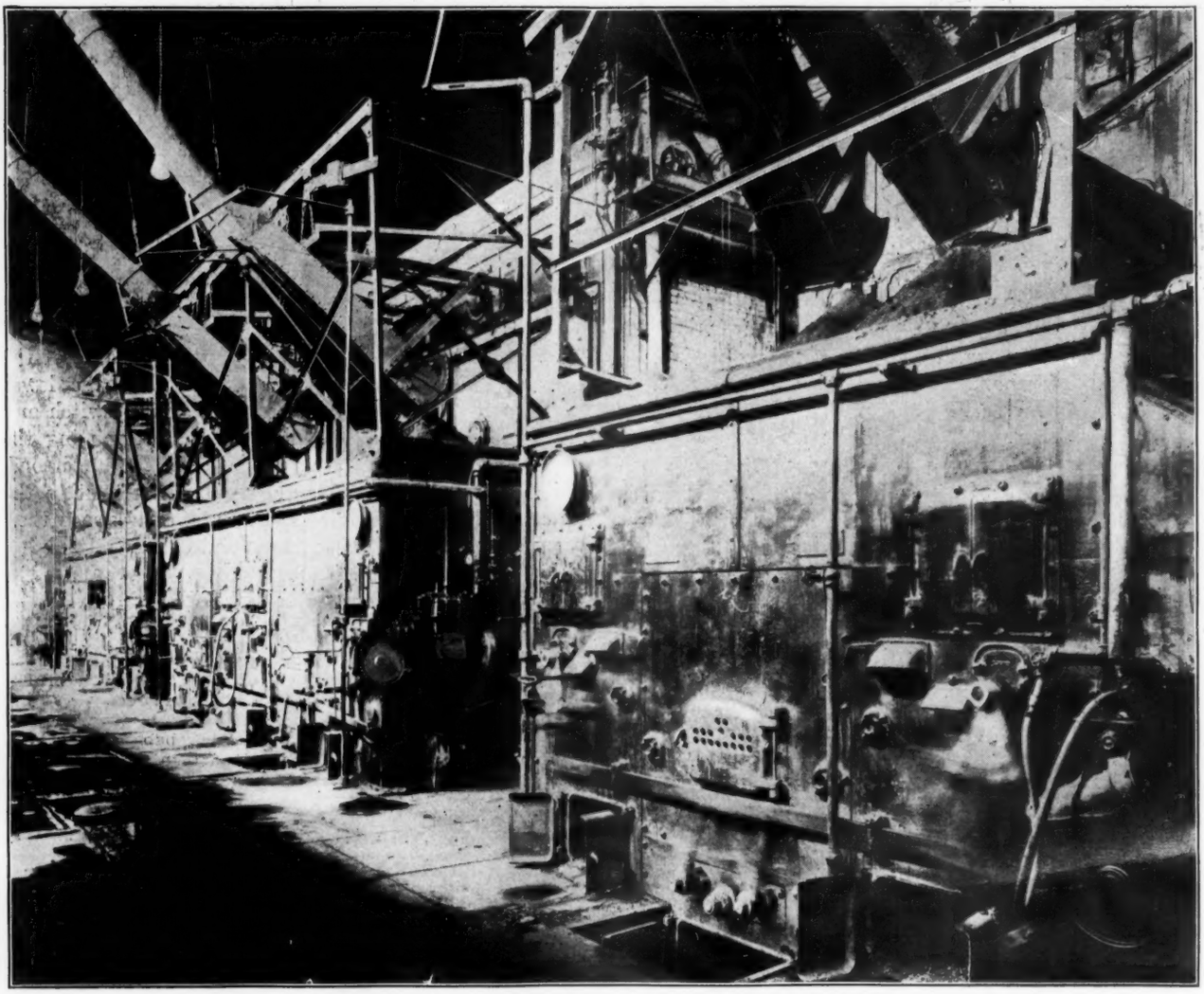


FIG. 1. BOILER ROOM, LAPORTE LIGHTING AND HEATING PLANT

In the course of time the water was returned to an open heater and then pumped through the closed heaters to the system. This arrangement did not prove entirely satisfactory, and eventually a large open heater was installed to replace the closed heaters. A turbine-driven

centrifugal pump replaced the reciprocating pump, and an independent boiler feed heater was installed. In the beginning the boiler feed was drawn from the large heater, but the low water temperatures in moderate weather made this arrangement undesirable from the standpoint of economy.

Before going into details of the heating system, it may be of interest to give briefly the equipment of the electrical plant and the average load carried. In 1910 the property was taken over by the United Light & Railway Co., of Grand Rapids, Mich., but locally, it is known as the Laporte Gas & Electric Co. The generating equipment was immediately overhauled and the antiquated machinery which had been collecting since 1885 was replaced by standard three-phase, 60-cycle generators belted to Corliss engines. One of the units was rated at 250 kw. and the other two at 320 kw. It soon became evident that additional capacity would be necessary, so one of the large engine units was removed and a 1000-kw. turbo-generator put in its place. This machine now carries the entire load, although the two engine belted units are run at frequent intervals to keep them in tune. The turbine is an eight-stage machine of the impulse type, operating noncondensing on steam at 140-lb. pressure and no superheat. The guaranteed rate is 32 lb. per kw.-hr. It is the intention to install at an early date a second turbine, removing another engine unit to make room for it.

In the boiler room there are six water-tube boilers—four rated at 304 hp., one at 500 hp. and one at 250 hp. All have individual steel stacks 110 ft. high and are equipped with top-feed stokers. Coal is unloaded by hand from a railway siding into an open bunker running the full length of the boiler room. At the bottom of this storage the coal drops through gates into a continuous bucket conveyor running up over the roof and dumping into chutes leading to the various stokers. From a 400-lb. weighing box at the end of each chute, the coal is dumped into the magazine of the stoker and each weighing is registered. The ashes are wheeled to the boot of a bucket elevator and discharged near the roof to a chute leading down into a receiving vault. The fuel used is Indiana and Illinois screenings. From three to five boilers are required to carry the load.

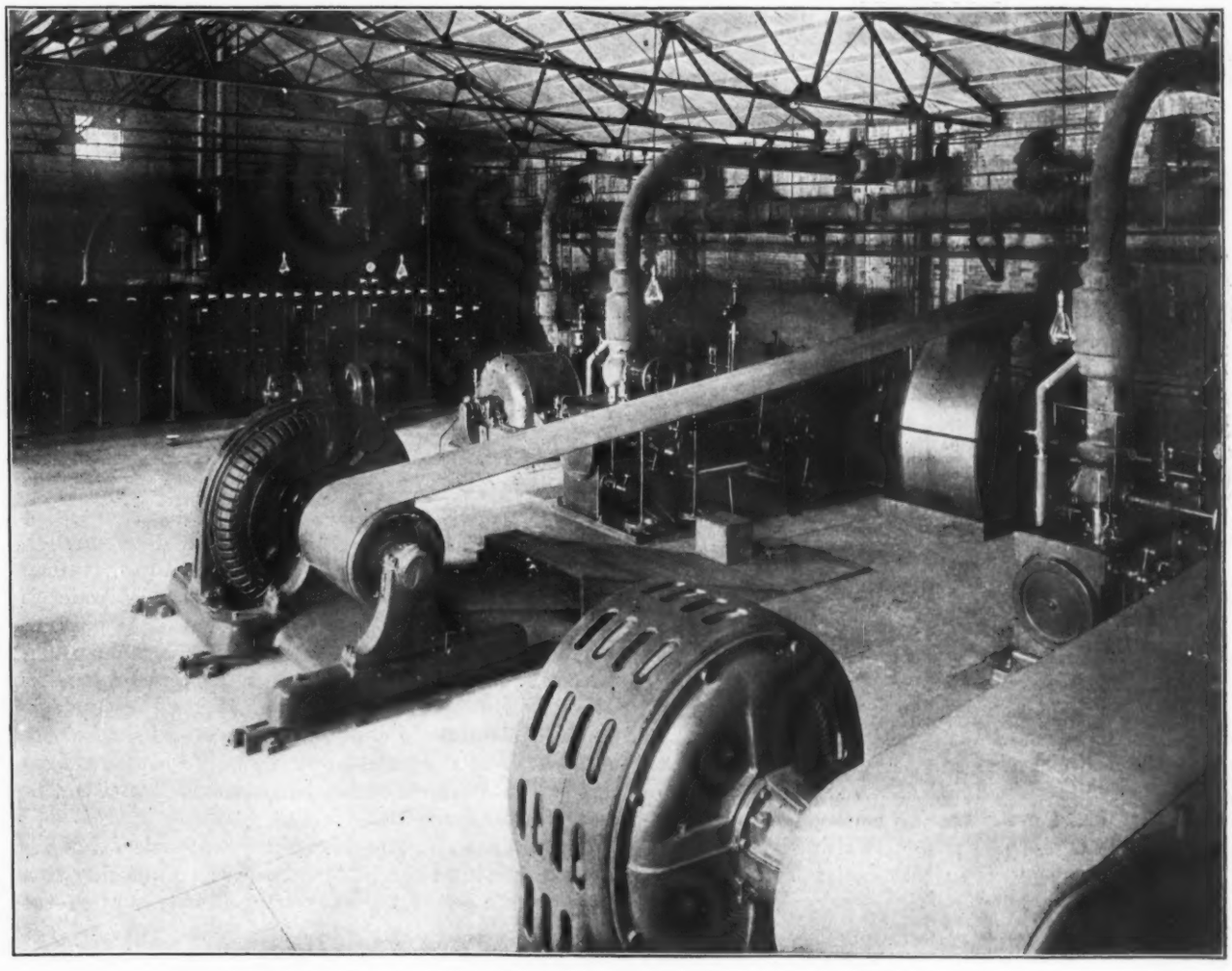


FIG. 2. ENGINE ROOM WITH HEATER SHOWING ABOVE SWITCHBOARD

The plant supplies current for street and commercial lighting and for power to 19 factories and to the city water works motor-driven pumps. Three-phase current is generated at 2300 volts. The pumping service is arranged for off-peak hours so that the load may be maintained fairly constant and the plant operated at a high load factor night and day. For the 24 hours the load will average about 750 kw. and the peak will not exceed 1000 kw. The turbine runs continuously for long periods. It is shut down every three months for inspection. When running at the average load it delivers to the heating system

over 20,000 lb. of exhaust steam per hour. This steam is exhausted to a 36-in. main and through the connections shown in Fig. 3 is delivered to the heaters. The large hot-water heater has a capacity of 125,000 gal. per hr. but the average circulation does not exceed 105,000 gal. The above quantity of steam will raise the temperature of the water 22 deg., and during the peak load the range will be greater.

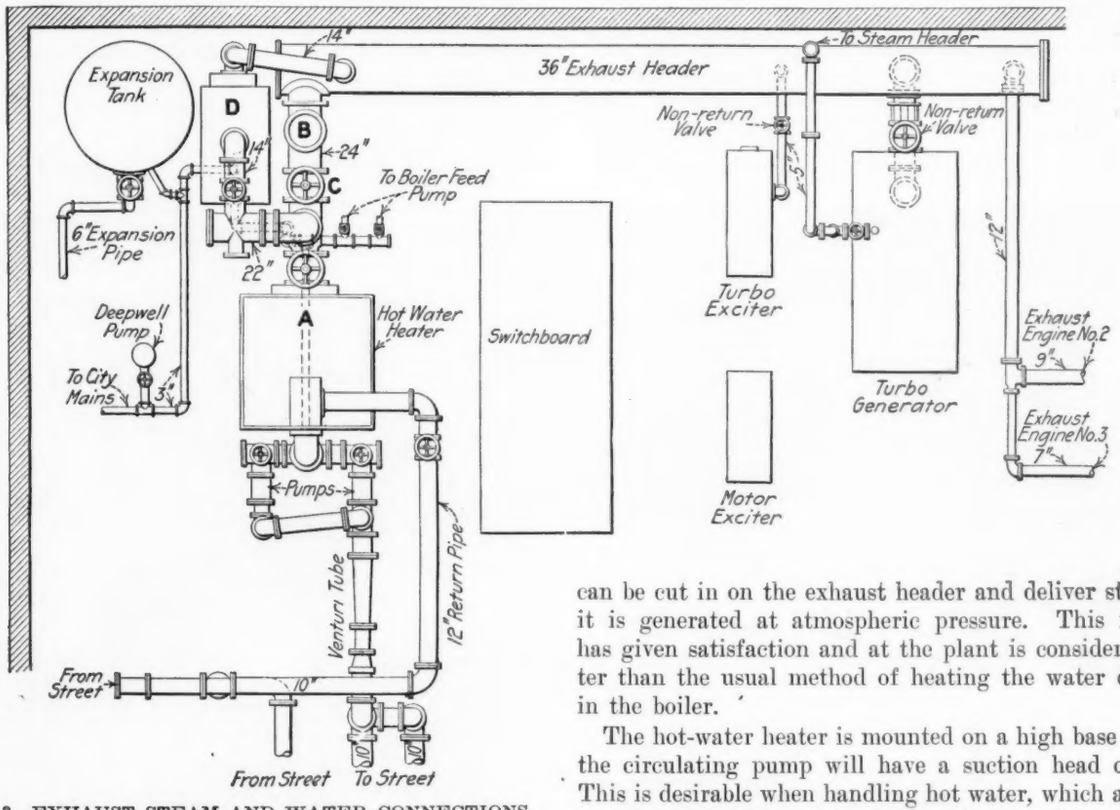


FIG. 3. EXHAUST STEAM AND WATER CONNECTIONS TO HEATERS

From the exhaust header steam passes to the large heater *A* through a 24-in. pipe. The connection *B* leads to the atmospheric exhaust, and valve *C* may be used to force more steam to the boiler-feed heater *D* or to atmosphere. During the heating season, however, there never has been any surplus steam. Valve *C* has been left open and the temperature in both heaters maintained at the proper points.

In weather below 20 deg. F. live steam is required. This is drawn from the main boiler header and through a manifold is introduced into the water heater through one of several pipes graduated in size to suit the varying demands for steam. In zero weather a 250-hp. auxiliary boiler is called into service. It is arranged so that it can be cut in on the exhaust header and deliver steam as it is generated at atmospheric pressure. This method has given satisfaction and at the plant is considered better than the usual method of heating the water directly in the boiler.

The hot-water heater is mounted on a high base so that the circulating pump will have a suction head of 8 ft. This is desirable when handling hot water, which at times has a temperature of 200 deg. and over. The water is forced out into the system at a pressure of 45 lb. by a 10-in. volute pump making 2200 r.p.m. The pump is directly driven by a horizontal steam turbine and handles with ease the 105,000 gal. per hr. required by the system, which consists of 13 miles of mains and service connections. Another turbine-driven pump, which is held as a reserve, is connected into the system so that it can be used at a moment's notice.

Through a 12-in. pipe the return water enters a dividing box on top of the heater. An open connection to a surge tank takes care of any irregularities. From the

PRINCIPAL EQUIPMENT OF LAPORTE ELECTRIC AND HEATING PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
6	Boilers	Stirling water-tube	Four 304-hp. One 500-hp. One 250-hp.	Generate steam	140-lb. pressure, stokers, natural draft	Babcock & Wilcox Co.
5	Stokers	Top-feed	Area 114 sq.ft.	Serve five smaller boilers		Murphy Iron Works Co.
1	Stoker	Top-feed	Area 118 sq.ft.	Serve 500-hp. boiler		Detroit Stoker Co.
1	Coal conveyor	Continuous-bucket		Coal from storage to stoker	Driven by motor	Stephens-Adamson Mfg. Co.
1	Ash conveyor	Bucket elevator		From boilers to storage	Driven by motor	Link-Belt Co.
1	Pump	Simple Burnham	14x9x16-in.	Feed boilers	140-lb. steam	Union Steam Pump Co.
1	Pump	Duplex	12x7x10-in.	Feed boilers	140-lb. steam	Henry R. Worthington
1	Turbine	Horizontal impulse	1000-kw.	Main generating unit	Noncondensing, 140-lb. steam, 3600 r.p.m.	General Electric Co.
1	Generator	Alternating-current	1000-kw.	Direct-driven by turbine	2300-volt, three-phase, 60-cycle, 3600 r.p.m.	General Electric Co.
1	Engine	Corliss	18x36-in.	Main generating unit	140-lb. steam, 125 r.p.m.	E. P. Allis
1	Generator	Alternating-current	250-kw.	Belted to Corliss	2300-volt, three-phase, 60-cycle, 600 r.p.m.	General Electric Co.
1	Engine	Corliss	22x36-in.	Main generating unit	140-lb. steam, 125 r.p.m.	Allis-Chalmers Co.
1	Generator	Alternating-current	320-kw.	Belted to Corliss	2300-volt, three-phase, 60-cycle, 600 r.p.m.	General Electric Co.
1	Exciter	Direct-current	35-kw.	Excite main units	125-volt, 1165 r.p.m., driven by 50 hp. ind. motor	General Electric Co
1	Exciter	Direct-current	35-kw.	Excite main units	125-volt, 3600 r.p.m., driven by turbine	General Electric Co.
1	Motor-generator	A.-c. to d.-c.	30-kw.	Direct-current to elevators	Driven by 2200-volt ind. motor, 900 r.p.m.	General Electric Co.
1	Heater	Sorge-Cochrane, open, filtering	125,000-gal. per hr.	Heat water of heating system	Exhaust steam from generating units	Harrison Safety Boiler Works
1	Heater	Sorge-Cochrane Metering	7200-gal. per hr.	Heat boiler-feed water	Exhaust steam from generating units	Harrison Safety Boiler Works
1	Pump	Volute	10-in.	Circulate water in heating system	Driven by Terry turbine, 2200 r.p.m.	Henry R. Worthington
1	Pump	Centrifugal	1860-gal. per min.	Circulate water in heating system	Driven by De Laval turbine, 4000 r.p.m.	De Laval Steam Turbine Co.

dividing box the water is distributed to eight sets of trays arranged in two horizontal planes. In dripping over these trays the water is finely divided and absorbs all of the heat in the exhaust steam. Owing to this fact it has been possible to maintain higher temperatures than with the closed heaters, and as there are two 8-in. air vents leading from the open heater no trouble has been experienced from air in the system. In addition, the pump suction is vented to the interior of the heater above the water line, so that a free passage to atmosphere is provided for any vapor or air released in the suction line. Butterfly valves on the vent pipes prevent air being drawn back into the heater should all steam be condensed and a partial vacuum form in the heater.

As in all heaters of this type, the water collects in the bottom and may rise to the overflow line. Just below this point, however, in the present installation, a connection is made to the boiler-feed heater, which has a capacity of 2000 hp., or 7200 gal. of water per hour. It is thus evident that all of the waste from the heating system is made up by condensate and the surplus flows by gravity to the boiler-feed heater. All condensation, then, is utilized and there is no need of a special trap or pump and receiver to get it back into the steam-generating system. Make-up for the boiler-feed heater is supplied from a deep-well pump or the city mains, the connections being so arranged that if the pump is out of order city water will automatically flow into the heater under float control. Indication of the quantity of water passing to the boilers is given by a special recorder and integrator.

TEMPERATURE SCHEDULE

Outside Air Deg. F.	Outgoing Water Deg. F.	Outside Air Deg. F.	Outgoing Water Deg. F.	Outside Air Deg. F.	Outgoing Water Deg. F.
70	101	45	152	20	188
65	116	40	160	15	195
60	128	35	168	10	202
55	136	30	175	5	210
50	144	25	182	0	210

An argument frequently advanced against the use of an open heater on a hot-water heating system is the loss of head due to the break in the water column; that is, the pump must pick up its supply from the heater and lose the advantage of the head on the return. Much of the 45-lb. head at which the water leaves the pump is taken up by the friction and resistances in the circuit. At the return end the head is not more than 10 lb. in the present case, and part of this is recovered by mounting the heater on a high base. The 8 ft. from the pump suction to the outlet of the heater is equivalent to 3½ lb., so that the loss in head is less than 7 lb. This is a small matter when compared to the advantages of the open heater previously enumerated, and the resistance that might be imposed by the tubes of a closed heater when filled with scale.

The possibility of getting oil into the heating system is another argument advanced against the open heater. This, of course, is possible, but a good oil separator of the proper capacity attached to the inlet of the heater usually solves this problem, particularly when the exhaust steam comes from a turbine. For a year previous to the installation of the turbine the heater received exhaust steam from the engine units, and according to reports there was no evidence of oil on the heater side of the separator. A considerable quantity was removed from the steam, but as the drain from the separator passed through a trap, much of it was separated from the water of condensation and reclaimed.

It has been the custom to blow down the heater twice a day and to clean out the sludge once a year. For the latter operation it is necessary to open up the heater, and this is done during the summer months, when the heating system is out of commission. Fortunately, the scale and dirt collecting during the year in the heater do not affect its efficiency or capacity unless the amount is excessive. This would not be probable in the present case, as the make-up is condensate. This point is of added importance as there is only one heater and it must operate through the entire season.

C. M. Cook is general manager of the company and Charles C. Foutz, superintendent. At one time these officials were skeptical as to the advantages of the open heater. The usual objections of loss of head and oil were advanced, but after three years of service they are fully convinced of the merits of the open heater, and in the near future it is their intention to install a duplicate unit.

The Purchase of Coal on Specifications

At an informal meeting of the committee appointed by the American Society for Testing Materials, held in New York in May, 1914, in connection with a proposed form of "Specification and Contract for the Purchase of Coal for Use in Steam Power Plants" the following questions were discussed:

1. Ash content and B.t.u. value have been and are widely used as factors for establishing the quality of coal bought under specifications, but the general conclusion has been reached that regular B.t.u. determinations on every sample are unnecessary, where all the coal comes from the same region and bed. In such case the B.t.u. value varies proportionately with the ash content, which, therefore, becomes a measure of heating value. When coal comes from different beds or regions, then B.t.u. values and analysis are of value.

2. Very few specifications in use make any mention of the clinkering qualities of coal, although this matter is of great importance and should be covered in all specifications. The fusing temperature of ash is used to measure this, but its method of determination should be further investigated, before definite recommendations can be made.

3. Moisture specifications were also discussed. Neither the "as received" nor the "dry" basis has proved altogether satisfactory. Moisture in coal is variable; its exact determination in any shipment is difficult, because of uncontrollable losses, and its amount is largely accidental. To use the "dry-coal" basis may give inaccurate values when coals of different nature are compared. In fact a satisfactory way of handling the moisture question has not yet been evolved.

4. Alternate methods of analysis are not desirable; a standard specification should always specify one standard method. The question of weights was also discussed, but no conclusions were arrived at.

As a general conclusion, it is believed by many chemists, engineers and others, that after the buyer of steam coal has decided on the description of coal he desires and what is best adapted to his use, there are only two items necessary, as regards analysis, in making up specifications, that is, the percentage of ash and the fusing temperature of the ash.

A standard percentage of ash of a given kind of coal (field or seam) insures a standard B.t.u. value; any change in ash percentage makes a corresponding change in B.t.u. value. The right ash-fusing temperature means no clinkers, and good combustion results if the coal is handled properly.

Where smoke laws are to be observed, it may be necessary to specify also a maximum volatile content of the coal, although even here it would generally be advisable and economical in the end to alter furnace and boiler conditions so that higher volatile, cheaper (usually) coals could be used.

Simplicity, equity and practicability should be the characteristics of all specifications for the purchase of coals.—F. R. Wadleigh, in "Coal Age."

All Classes of Pipe, casings, tubing, etc., heavier than standard are the same outside diameter as standard, the extra thickness always being on the inside. Above 15 in. inside diameter, pipe and tubing are always known and spoken of by their outside diameters, and the thickness of metal desired must be specified. All boiler tubes are known by their outside diameters.

Tests of Hand and Mechanical Soot Blowers

By A. W. Conklin*

SYNOPSIS—Shows by curves and other data the economical advantages of mechanical over hand-operated soot blowers.

Generally, the man in charge of the boiler room has but a vague idea of the heat losses which may be caused by the presence of soot on the tubes or drums of the boilers, although he may admit there is some loss.

Where hand-operated jets are used, the disagreeable nature of the work, hot, dirty and awkward as it is, relegates it to the lot of the ashman, to be looked after during such time as he can spare from his regular duties. His tasks are arduous and usually consist of running the coal crusher, cleaning the conveyor track in the ash tunnel, removing clinker thrown from combustion chambers, wheeling away piles of soot and scale from the rear of the boilers, and blowing flues. If, then, his regular work is neglected, it will be immediately detected by evidences which loom large before him, while if the soot blowing is shirked, who will be the wiser? Where such conditions exist it would pay to install mechanical blowers or hire a man to blow flues with a hand lance and do nothing else. Of the two, the former involves higher first cost and considerable outlay of money if the plant is a large one, but it is the writer's experience that in the long run the latter is the more expensive.

The steam or air lance is better than nothing, but at best is a poor makeshift. The time required to clean a boiler with it is about three times that necessary with a

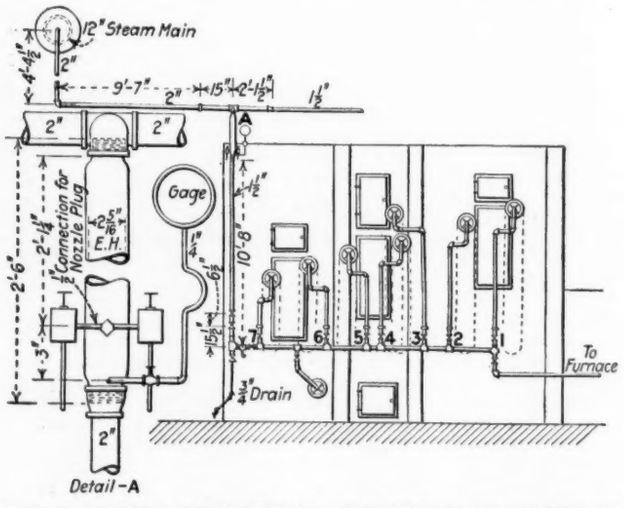


FIG. 1. PIPING CONNECTIONS FOR STEAM-FLOW METER BETWEEN MAIN HEADER AND SOOT BLOWER

mechanical blower, and the results obtained are about one-third as good. It is like trying to wash a pavement with a single jet of water—the mud is driven from one spot to another and much time and water are wasted before the dirt is driven to the sewer. The street flusher, with its arrangement of nozzles or numerous jets, sprays the water over the whole surface and carries all the refuse before it in a comparatively short time and with a small amount of water.

On a series of comparative tests in soot blowing it was found that the amount of steam required for one operation of the mechanical blower was about the same as that used in blowing the boiler by hand and that the boiler equipped with the soot blower was absorbing mark-

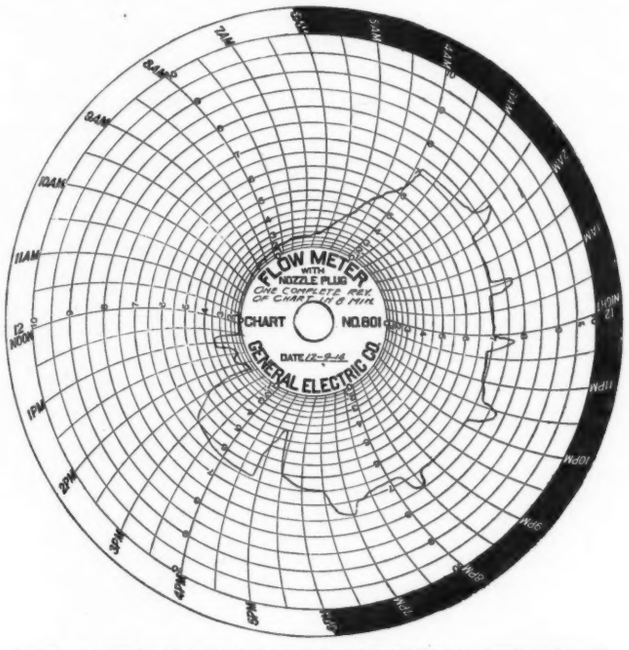


FIG. 2. STEAM CHART WITH BLOWER IN OPERATION

edly more heat than any of the boilers on the line that were hand-blown. In other words, the amount of steam used by the blower in 6 min.—the time required to clean the boiler—was nearly the same as that used by the steam lance in 25 min. for the same operation. The soot blower showed a saving of 5 per cent. over hand-blowing, because the heating surfaces were more thoroughly cleaned.

The writer's experience shows that at least 2 per cent. of the fuel consumed could be saved by keeping the tubes free from soot. This means much in a plant where the fuel consumption is high, as it is in many industrial plants.

The following data on steam consumption of mechanical soot blowers were obtained to determine the steam charge for soot blowing. This charge is dependent on the number of times the boilers are blown per day and also upon the length of time the blower is used in cleaning a boiler. Therefore, the questions arise—first, how often should the boilers be blown to secure the highest economy? and second, how much time is required in operating the cleaning elements to secure results which will give the highest economy for the least amount of steam?

The answer to the first question depends largely on local conditions—coal used, available draft, the rate at which the boilers are driven, and in general on the clean-

*Combustion engineer, Pennsylvania Salt Works, Wyandotte, Mich.

liness of the heating surfaces. Once a boiler is clean, it requires less blowing to keep it so than it does to clean one in which the soot is allowed to accumulate until it is caked between the tubes. The answer to the second question depends on the available steam pressure and the efficiency of the apparatus. The proper placing of blower elements and the nozzle design are important factors in

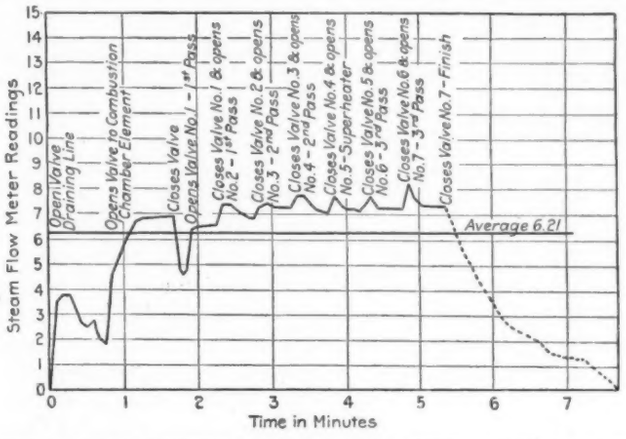

Steam Flow Meter Readings
Time in Minutes
Open Valve Draining Line
Opens Valve to Combustion Chamber Element
Closes Valve
Opens Valve No.1 – 1st Pass
Closes Valve No.1 & opens No.2 – 1st Pass
Closes Valve No.2 & opens No.3 – 2nd Pass
Closes Valve No.3 & opens No.4 – 2nd Pass
Closes Valve No.4 & opens No.5 – Superheater
Closes Valve No.5 & opens No.6 – 3rd Pass
Closes Valve No.6 & opens No.7 – 3rd Pass
Closes Valve No.7 – Finish
Average 6.21

FIG. 3. FLOW-METER READINGS PLOTTED AGAINST TIME

determining the time required to clean the heating surfaces. In water-tube boilers of the B. & W. type, 5 to 10 min. is sufficient and further operation usually wastes steam.

In these tests the steam consumption was determined with a General Electric flow meter, type F. A trial run using a standard 2-in. nozzle plug in a section of 2-in. extra heavy pipe, showed a steam velocity higher than could be recorded on the flow meter when the soot blower was in operation. The pen immediately went to the

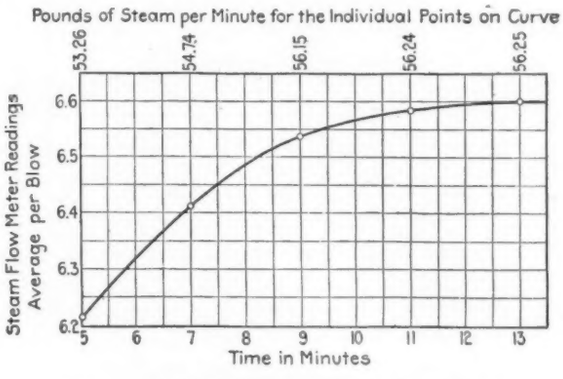


FIG. 4. INFLUENCE OF TIME ON STEAM CONSUMPTION OF BLOWER

limit of the scale and remained there during the period required to blow the flues.

Accordingly, a section of 2½-in. extra heavy pipe was inserted, as shown in the piping diagram, Fig. 1, and the nozzle plug installed, as shown in the detail *A*. This arrangement was used throughout the test. The steam gage was placed about three inches below the nozzle plug to get the pressure as near this point as possible. A standard test gage was used, which was first tested with dead weights to be sure it was correct. The layout shown in Fig. 1 used a soot blower equipped with 1½-in. piping to the blowing elements and referred to as a 1½-in. blower. On another boiler equipped with a 2-in. blower, it was necessary to use a section of 3-in. extra heavy pipe and a 3-in. nozzle plug to get proper pen readings.

The total time of operation of the blower was 5 to 7 min., and to get a complete revolution of the flow-meter chart in 8 min., each of the half-hour divisions had to pass a fixed point on the meter every ten seconds. The center jam nut was removed to allow the paper to move freely, and while an observer called "time" every five seconds, the chart was moved by hand so that every ten seconds one of the half-hour divisions passed the fixed point on the meter, and each five seconds the fixed point was half way between the half-hour divisions. One of the charts is shown in Fig. 2. In this way it was not difficult to move the chart at a fairly uniform rate, and with the time element so small there was not much chance for a large error in the curve. A few typical curves were plotted by having a man with a watch call "time" every five seconds and record the readings of the flow-meter pen, given by an observer. One of these curves is shown in Fig. 3.

After the steam was shut off from the last valve, or No. 7, the operation of soot blowing ended and no more steam was used, but it will be noticed that the pen arm

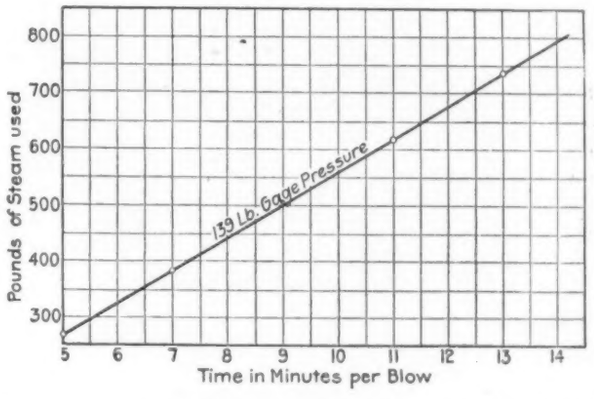


FIG. 5. TOTAL STEAM REQUIRED FOR GIVEN PERIODS THAT BLOWER IS IN OPERATION

did not drop at once to zero. Instead, it fell rapidly immediately after the valve was closed, then slowly till the zero point was reached. This was owing to the water forcing its way out of the nozzle plug, and this section of the curve was not taken into consideration in obtaining the average pen reading during the run. The average used was that of the readings from the time steam was admitted to the soot blower till the last valve was closed and the operation finished. A curve, Fig. 4, shows the influence of time on soot-blower steam consumption. Five-second readings were taken, as described, while the blower was operated for different lengths of time.

The longer the time of blowing, the nearer the average pen reading approaches a maximum which is determined by the amount of steam used by the blowing elements and the less this average is affected by the area below the line in draining valves, etc., when the operation is begun.

Fig. 5 shows the total amount of steam required for any given period during which the soot blower is operated. The pressure was 139 lb., and the steam was superheated about 20 deg. F. The pressure drop from the main steam header to the nozzle plug when the blower was in operation was about 10 lb.

Fig. 6 shows curves giving the steam consumption of a 2-in. blower at different steam pressures and 20 deg. F. superheat.

Fig. 7 shows the steam consumption using a hand lance employed in blowing tubes. With the lance, neither the superheater tubes were blown nor was the rear combustion chamber cleaned, but the steam consumption was

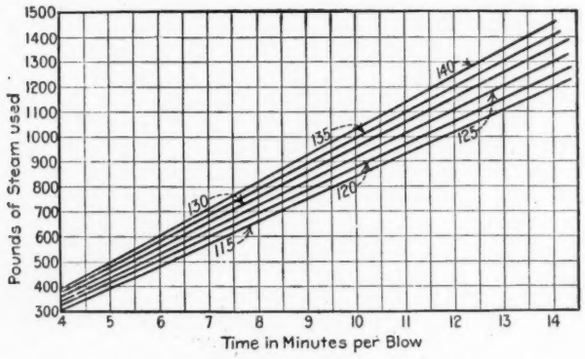


FIG. 6. STEAM CONSUMPTION OF 2 IN. BLOWER FOR VARIOUS PRESSURE

about the same as that required for one blow with the mechanical blower.

TEST ON HAND BLOWING WITH STEAM LANCE
(¾-in. connection and ½-in. blowing element)

Average of 296 Readings		2.824 Flow-Meter Pen Reading	
K_1	= 1.94 in. internal pipe diameter	K_1	= 350
K_2	= 148 lb., average pressure	K_2	= 0.988
K_3	= 20 deg., F. superheat	K_3	= 0.987
K_{cp}	= internal mechanism No. 6	K_{cp}	= 1.000

The multiplying constant for a given set of conditions is derived from the following factors (See G. E. Co.'s "General Instruction Book No. Y-448-2" on recording and integrating flow meters):

1. The internal diameter of the pipe, pipe reducer, or orifice.
2. The pressure of the fluid.
3. The quality of the fluid.
4. The internal mechanism of the flow meter according to number of same.
5. The type of nozzle plug, normal or high velocity.

To enable the operator to obtain, with the least work of computation, the constant for a given combination of these variable factors, diagrams have been prepared for steam, air and water and provide that the readings obtained will be in the units most appropriate for the fluid being metered. These curves may be found in the flow-meter instruction book and are designated as follows:

Curve 1 = Internal pipe diameter, gives the constant K_1.

Curve 2 = Steam pressure, gives the constant K_2.

Curve 3 = Quality, moisture or superheat, gives constant K_3.

Internal-mechanism number gives the constant K_{cp}.

The type of nozzle plug used in the tests was for normal velocity.

Twenty-nine minutes was required to blow the tubes. The steam was used 24.66 min., and the balance of the time was consumed in changing from one pass to the other. The steam rate was $341.3 \times 2.824 = 963.86$ lb. per hr., or 16 lb. per min. at 138 lb. pressure. Steam used during the period of blowing, 396.13 lb.

As steam consumption data without temperature tests showing the increased heat absorption of clean flues are incomplete, the following summary of a number of pyrometer readings is given.

Hoskin's thermo-couples, 6 ft. long, were placed throughout the path of the hot gases as follows: Couple No. 1, bottom row of tubes, 1st pass; couple No. 2, top row of tubes, 1st pass; couple No. 3, bottom row of tubes, second pass; couple No. 4, top row of tubes, third pass. The couples and galvanometer were checked at the factory before being used and the readings given are the averages of a large number of tests made under various conditions, the initial temperatures being nearly the same in each case.

No. 1 Hand Blown	No. 1 Mechanically Blown	No. 2 Hand Blown	No. 2 Mechanically Blown
1542	1535	929	901
1651	1651	925	925
1731	1730	1007	971
1863	1848	956	940
No. 3 Hand Blown	**No. 3 Mechanically Blown**	**No. 4 Hand Blown**	**No. 4 Mechanically Blown**
689	649	620	520
705	648	605	525
752	665	636	542
762	633	612	520

The temperature difference at No. 4 couple, which was taken as the release, shows anywhere from 80 to 100 deg. F., which corresponds to a saving of from 4 to 5 per cent. This is possible not only because of the increased efficiency of the mechanical blower over the steam lance, but because the mechanical blowers permit cleaning the boilers oftener.

Fig. 7 shows the steam consumption of the hand lance for any given period of time and is a straight-line curve.

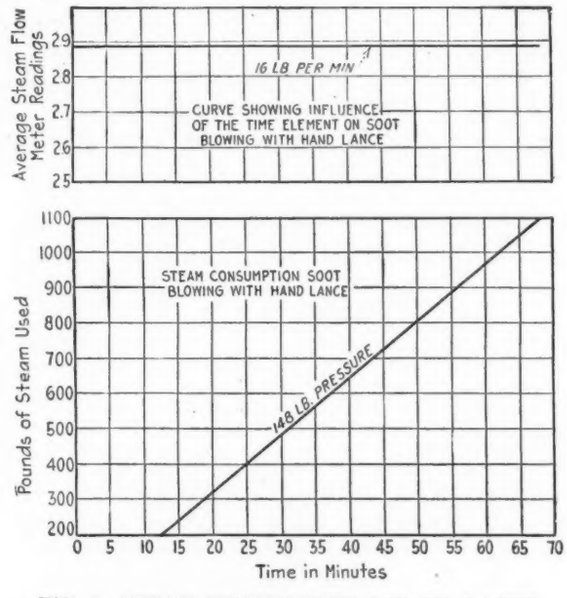

Average Steam Flow Meter Readings
16 LB PER MIN
CURVE SHOWING INFLUENCE OF THE TIME ELEMENT ON SOOT BLOWING WITH HAND LANCE
Pounds of Steam Used
STEAM CONSUMPTION SOOT BLOWING WITH HAND LANCE
148 LB. PRESSURE
Time in Minutes

FIG. 7. STEAM CURVES WHILE HAND LANCE WAS IN OPERATION

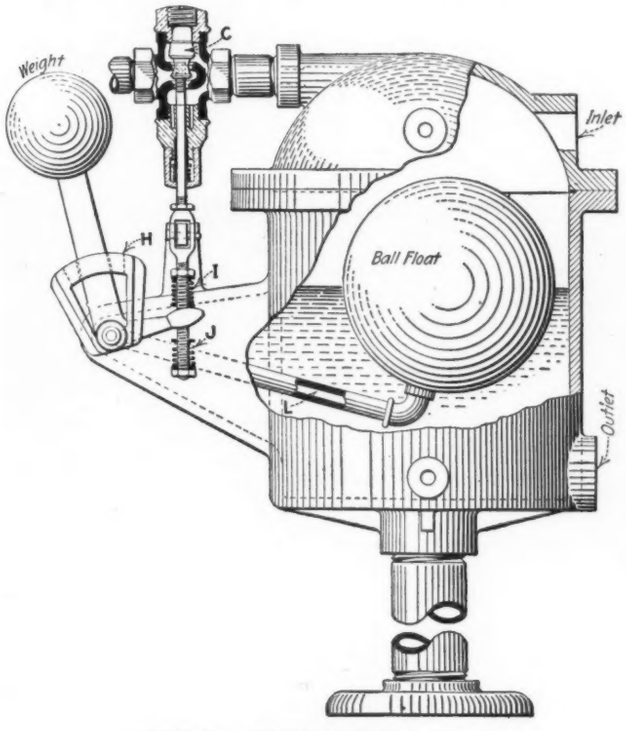
The upper curve shows the influence of the time element on the steam consumption when this method of soot blowing is employed and is also a straight line, for the reason that a constant amount of steam is used when the jet is in operation, regardless of the length of time required to clean the boiler. This constant is dependent upon conditions of pressure, quality, size of orifice, etc., and in this case was about 16 lb. per min.

It is apparent that the amount of steam per minute is much less with the hand lance than with the mechanical blower, and it is therefore impossible to accomplish the same amount of work per minute, because of the smaller volume of steam and its inefficient application. Further, losses due to infiltration of air are inevitable where the hand lance is used, though they can be largely prevented with some makes of mechanical blowers.

Lytton Thermo Syphon Trap

This trap is designed to handle condensation under various conditions of pressure, vapor and vacuum installations, one-pipe layouts, or any type of steam-heating systems.

Details of the trap are shown in the accompanying illustration. In operation the compound steam and vent valve is actuated by the rise and fall of a ball float, which moves the weight rocker *H*, and this movement carries the weight to the left or to the right beyond a vertical position. When the float goes to the bottom of the trap the weight falls to the right and closes the steam valve and opens the vent. When the float rises to the top, the weight tumbles to the left, closes the relief *C* and opens the steam valve. Buffer springs *I* and *J* absorb the shock of these movements and render the operation noiseless.



LYTTON THERMO SYPHON TRAP

The float is always in communication with the atmosphere, and any moisture that may sweat through the metal is ejected on each upward movement of the float through the port *L*.

This trap is manufactured by the Lytton Manufacturing Corporation, Franklin, Va. It discharges the condensate directly into a boiler, regardless of the pressure in the boiler or in the system. For instance, on a heating installation there might be from 1 to 10 lb. pressure on the boiler and from 1 to 10 in. vacuum on the heating system. The trap, however, operates with a positive action under all conditions.

The First Discovery of Coal—Up to the present time the first mention of coal in the United States has been credited erroneously to Father Hennepin in 1689. The first discovery of coal in the country which afterward became the United States was made by Joliet and Marquette in 1673. Joliet's map of 1674 shows the location of "charbon de terre" (coal) near the present City of Utica, Ill. In "Coal-Mining Practice in District IV," Bulletin 12 of the Illinois Coal Mining Investigations, by S. O. Andros, copies of Joliet's and Marquette's maps are published.—"Coal Trade Bulletin."

JUST FOR FUN

No Benefit from the Change

One of the air compressors at a works where I was employed had its intake in the engine room. The engineer was ordered to extend it outside in order to get it away from the heat and moisture. He did this next day, placing it immediately over the exhaust from a small non-condensing engine!—Donald M. Liddell, Elizabeth, N. J.

WE'D LIKE TO SEE THIS "WHITE HOPE" WIN
(W. A. Ireland in the Columbus "Dispatch")

Visible Effect vs. Invisible Cause

I showed a fellow through our street-railway plant last week, explaining how electricity was generated and that it was invisible, etc. About that time I had to start up another unit to take care of the peak load. It happened that there was considerable sparking at the brushes. "Say, you said electricity was invisible," he remarked. "Look at all the juice leaking out there now!"—A. Lamarine, New Bedford, Mass.

A Shocking Incident

A steel stack delivered at a power house located near a school for colored children was forthwith appropriated as a recreation feature, much to the detriment of the shape of the stack. To abate the nuisance, the engineer blocked the stack off the ground and connected it through a switch and resistance to the railway circuit. During the following recess, when the stack was filled with kids as usual, the switch was closed and quickly opened again. It was certainly "worth the price of admission" to look through the inside of the stack and see the promiscuous bunch of pickaninnies on any part of their anatomy, and using any mode of locomotion except their feet, trying to get out. Thereafter the stack was left as desolate as a haunted house.—John F. Hurst, Louisville, Ky.

Life Work of Centennial Engine

By S. H. Viall

SYNOPSIS—A brief review of the services rendered by the mammoth Corliss exhibited at the Centennial Exposition in 1876. Its principal dimensions, the repairs that were made, and some of the oddities associated with its operation.

In the article on the Panama-Pacific Exposition appearing in the Feb. 23 issue of Power, a short description was given of the Corliss engine exhibited at the Centennial Exposition in 1876. This engine has long been famous. It has been referred to times innumerable in the engineering press and is remembered by thousands who saw it at the Centennial. At the time of the exposition it was the largest engine that had ever been built; in fact, it was so large that the press commented on it to the effect that it would prove a "white elephant." After the close of the exposition there would be no use for it, as no manufacturer would ever want an engine so powerful. A review of the services it has since rendered may then be of interest.

At the close of the exhibition the engine was dismantled and shipped to Providence, R. I., where it remained in storage until 1880, when its builder, the George H. Corliss Co., finally found a purchaser in George M. Pullman, who was then building at Pullman, Ill., a new works for the manufacture of sleepers, passenger and freight cars, and who was progressive enough to dare attempt to use the immense engine.

The engine, Fig. 1, weighed 700 tons, and the fact that it required a train of 35 cars to convey it to Pullman will give some idea as to its size in proportion to other equipment of the day. Officially, the engine was started at Pullman on Apr. 5, 1881, and was continued in use until the fall of 1910, when it was finally dismantled. The room in which it was erected (and it was the only equipment in the room) was 84 ft. square and 66 ft. high above the operating platform. Throttle valves, condensers, driven pinion and other parts were below, in a basement. Around the platform were wide aisles for the thousands of visitors who were conducted upon sight-seeing trips through the works. The engine room was kept like a palace, the floor being polished every other day, and the bright work on the engine was gone over at least once a week. An idea of the size of the engine can be obtained by comparison with that of the men standing upon it.

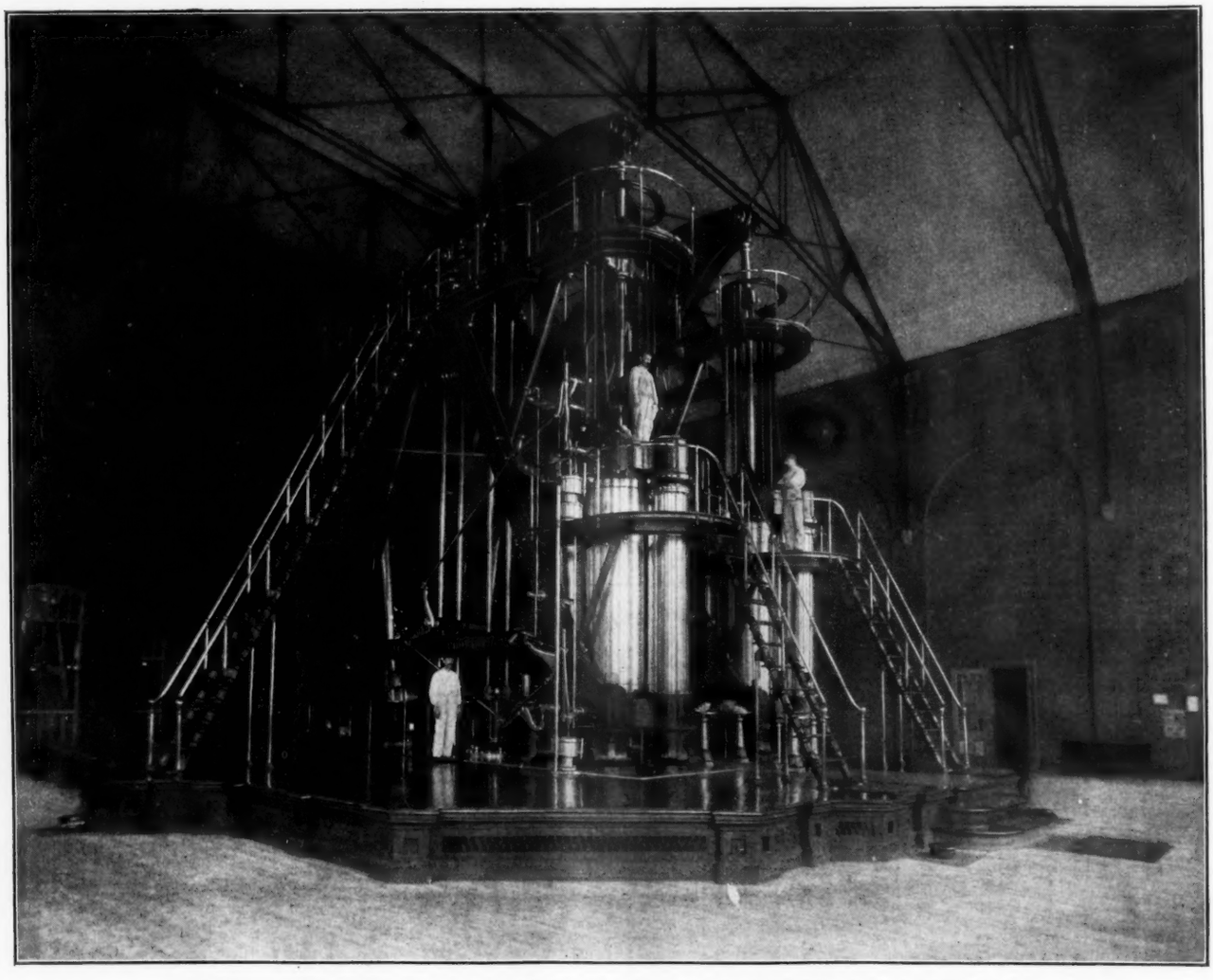


FIG. 1. THE CENTENNIAL ENGINE AS INSTALLED AT THE PULLMAN WORKS

As one faced the gage board on the operating platform, he was facing due east and looking at the flywheel, with an engine cylinder upon his right known as the "south engine," and another on his left known as the "north engine." The unit was really two vertical simple condensing engines with Corliss valve gears and steam-jacketed cylinders set on A-frames. A common flywheel was mounted between the two engines, and both were controlled by one governor. With these two exceptions the engines were distinct units. Each had its own throttle valve, walking beam, jet condenser, framework and foundation. When originally installed, steam was supplied to the engine from return-tubular boilers with safety valves set at about 80 lb., but for the last eight to ten years these had been supplanted by water-tube boilers carrying 125 lb. pressure. A reducing valve in the steam line at the engine controlled the operating pressure. Some of the principal dimensions of the engine were:

Cylinders, 40 in. by 10 ft.

Main steam line, 18 in. diameter.

Piston rods, 6¼ in. diameter.

Walking beams, web pattern, 27 ft. long, 9 ft. wide at center, weight 11 tons each.

Connecting-rods, 25 ft. long, 10 in. diameter at center, tapering to 6 in. at ends.

Cranks, one on each side of the flywheel, mounted outside of the crankshaft bearings, weight 5 tons each.

Crankshaft, 19 in. diameter, 12 ft. long.

Bearings for the crankshaft, 18 in. diameter, 24 in. long.

Geared flywheel, mounted between bearings, 29.7 ft. in diameter, 24-in. face, pitch of gear 5⅛ in., 216 teeth. The

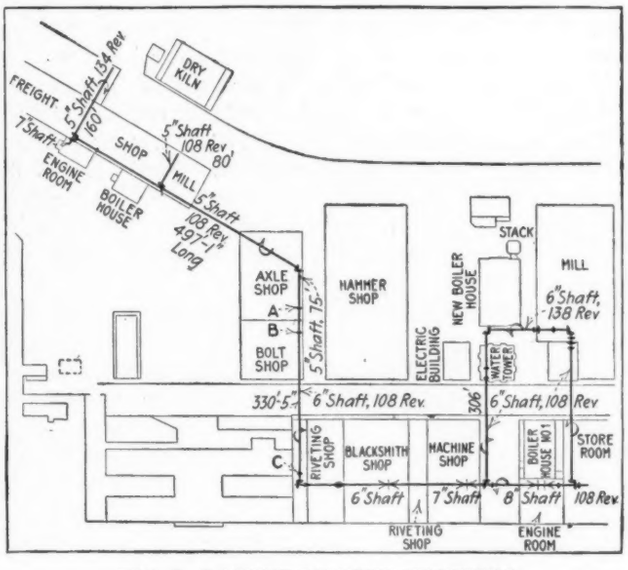


FIG. 2. LAYOUT OF LINE SHAFTING

wheel was built of 12 sections held together by bolts, there being 36 bolts in the hub at the crankshaft. The total weight of wheel was 56 tons.

The geared flywheel drove a pinion mounted on a pinion shaft 14 in. in diameter, which in turn was coupled to the main lineshaft. This pinion was below the operating floor. It was 9.9 ft. in diameter and weighed 17,000 lb.

Each half of the engine was fitted with its own jet condenser and air pump of the bucket-plunger type. Cylinders of the air pump were 36x24 in. The pumps were operated by connecting-rods from the walking beams. There were 24 valves in the air pump, 8 in. in diameter on the suction and 9 in. in diameter on the discharge, made of rubber 1 in. thick.

The engine was the main source of power for driving machines in the car works, and for the distribution of this power there were 2464 lin.ft. of main lineshafting from 8 to 5 in. in diameter. This shafting was mounted in tunnels approximately 4 or 5 ft. below the surface of the ground. Fig. 2 shows a diagram of the main lineshafting as it was in 1906. There were eight sets of cast-iron gears on this shafting, and after the latter had been brought up to speed, it required 140 i.hp. to keep it revolving. Besides the main lineshafting there were approximately 13,000 ft. of overhead shafting, 3000 pulleys,

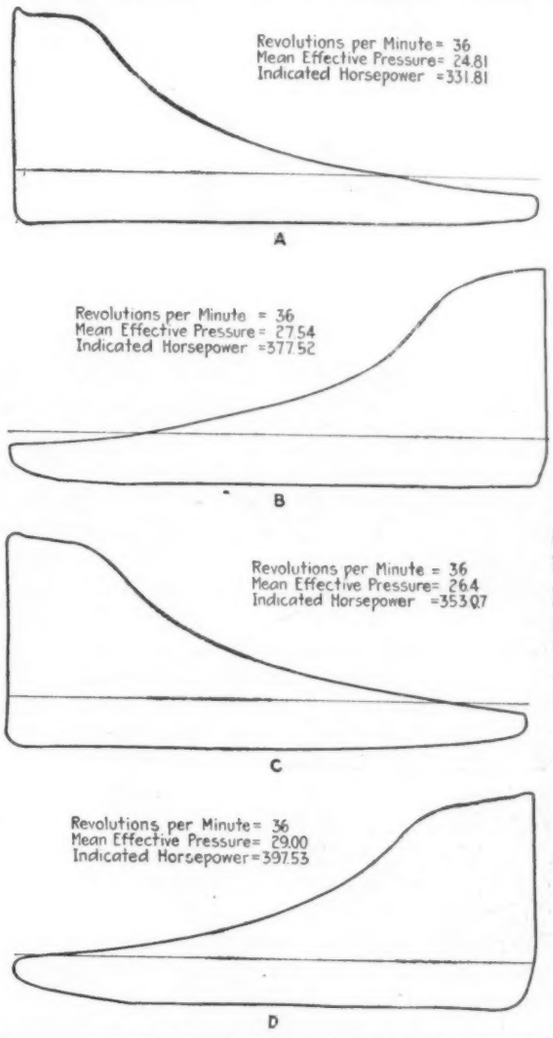


FIG. 3. A SET OF INDICATOR DIAGRAMS TAKEN IN 1904

3000 pillow blocks and hangers, and 89,000 ft. of belting of all kinds.

Besides the big Corliss, there were in use in the plant some 14 or 15 engines ranging from 150 to 900 hp., 15 to 20 between 20 and 100 hp., and many smaller than 20 hp. for driving fans and other apparatus. When the Centennial engine was shut down in 1910, with but a few minor exceptions all of these engines were abandoned and motor drive was used throughout the works. The load had increased, but two turbine-driven generators, rated at 1500 kv.-a. each, were installed and it was exceptional when one machine could not carry the load.

Although famous for its great size, the Centennial Corliss was economical as well. Statements by engineers of the Pullman company are to the effect that the engine showed upon repeated tests a steam consumption of from 15 to 16 lb. per i.hp.-hr. This does not take into account the live steam condensed in the cylinder jackets. The indicator diagrams reproduced in Fig. 3 were taken Dec. 21, 1904, and show about as large a load as the engine carried regularly—1460 hp., an average initial pressure of 42.3 lb. and an average vacuum of 25.5 in. It is not

known that these diagrams are from the same set. It was customary when taking indicator diagrams (which was done at least once a month) to take several sets, four diagrams made simultaneously being a set. The variation in initial steam pressure would seem to show that the cards were from different sets, although all were made on the same day.

Statements by engineers who worked with this engine are to the effect that it was usual, with 72-deg. cooling water, to have a discharge temperature of 130 deg. and a vacuum of 24 to 26 in. With 35-deg. cooling water and a discharge temperature of 110 deg., a vacuum of 28 in. was carried.

One diagram, taken Feb. 4, 1895, is shown as an example of an almost ideal Corliss-engine card. Comparing this diagram, Fig. 4, with the diagrams taken in 1904, it will be seen that the steam line of the former holds up better. In 1895 the load was comparatively light and the initial steam pressure was only 21.8 lb. Apparently, the valve ports on this engine were slightly small and caused wire-drawing when the engine was fully

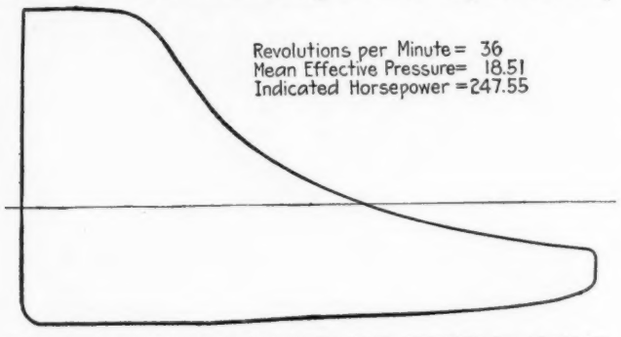


FIG. 4. A DIAGRAM TAKEN IN 1895, WHICH IS ALMOST IDEAL

loaded. The diagram in Fig. 4 indicates 247.5 hp. for the crank end of one engine, or approximately 1070 hp. for the engine as a whole.

The greatest power ever developed from the engine was in 1887 or 1888, when indicator diagrams taken from the north engine showed 1260 hp., or 2520 hp. for the unit. The initial pressure at this time was 75 lb., although it was seldom that an initial pressure of more than 40 lb. was used. The strain upon the engine due to this load of 2520 hp. was so great that it cracked the brick foundations upon which the engine stood, and it was necessary to pour 2200 lb. of lead into the cracks that developed. Following this experience, the engine always had a click whenever the crank on the north engine came on the crank-end center. This click was never located until the engine was dismantled in 1910, when it was found that one of three bolts holding a section of the flywheel at the hub was broken.

Following the strain of 1887 or 1888, the foundations continued to become worse, and finally, in 1902 or 1903, the old foundation of the north engine was drilled so that angle irons could be inserted and grouted in with concrete. A concrete retaining wall was built around the old foundation. The engine was down for a week while this work was being done.

During a service of nearly thirty years, this walking-beam engine had the following repairs:

1883. One new cylinder head, one new piston head.

1886. A new pinion shaft, one new beam-end pin.

1889. One new piston head, one new beam-end pin, one new set of bearings, one new cylinder on north engine. While installing the new cylinder, the connecting-rod of the north engine was taken off and the south engine carried as much of the load as it was able to. After the work on the north engine was completed, it was connected up to the flywheel and carried the load while repairs were being made on the south engine.

1890. One new cylinder on the south engine, new brasses for crank of south engine, new walking beam on south engine.

1902 or 1903. Concrete reinforcement of foundation of north engine; valve chamber, head end south engine, rebored.

1905. New pin for walking-beam end of the pump rod for north engine, 6-in. spray pipe in condenser broke off, new connecting-rod pin for the beam end of the rod for south engine.

Originally, a steel plate acted as a spring between the valve bonnets and the valves. These plates were in size and shape like a large dinner plate. They were not satisfactory, as the spring would break near the rim. Finally, they were replaced by a piston and spring and a bolt run through the bonnet pressing in on the piston. This kept the valve from knocking and moving sidewise.

The governor was not wholly satisfactory, as with a sudden wide spring in the load the engine would either race or drop her valves and stop. The normal speed was 36 r.p.m. If the engine were to speed up to 39 or 40 r.p.m., one would think it was going to leave the foundations, and the pump rods would vibrate as if they would snap. The engine took a great quantity of oil. To the various bearings as much as 14 gal. was supplied per day of 10 hr. Much of this was reclaimed and filtered, so that one barrel of new oil per month supplied the demand. The cylinders and piston rods took about ½ gal. of oil in 10 hr. The oil cups on the four pins in the walking beams held a supply which would last for 5½ to 6 hr. To fill these cups it was necessary to shut down the engine. It was first stopped on one center to oil one end of each beam, and as the engines were 180 deg. apart, it was necessary to turn them over one-half revolution to fill the other two cups. Much of one man's time was required to oil the engine and another's to watch its operation, as the governor did not hold it under control under all conditions.

In the operation of this engine there were several other odd features that have been gathered from the men who handled it. It was quite a common performance to run the engine nights and holidays on light load, when the reducing valve at the engine would lower the pressure of the steam below atmosphere. The lineshafting traveled 108 r.p.m. to the engine's 36 r.p.m. The engine would make a little more than one revolution before the end of the shaft farthest from the engine would begin to turn. There were three sets of cast-iron gears between the engine and this point. Part of the lost motion was backlash in the gears, but most of it was due to torsion in the shaft. During the last few years the Centennial engine did not carry all of the shafting in the shops when it was fully loaded. The shafting was opened up at *A*, *B* or *C*, Fig. 2, depending upon load conditions, and a 900-hp. engine carried that part of the main lineshafting cut off.

After the old engine had been dismantled, it was placed in storage for several months. As no one apparently cared for it, it was finally sold as junk at a price believed to be about $8 per ton. Thus passed an engine that in its youth was considered to be a "white elephant" because of its immense size and power, which in its old age was really a small unit when compared with more powerful engines that had been developed during its life.

"Bull Dog" Shaft Couplings

In the "Bull Dog" shaft coupling the roller-ratchet principle is applied to fasten couplings, collars and pulleys in place on the shafting. The coupling is a cylinder with two eccentric chambers inside. Each chamber has two steel rollers, held parallel with each other by a light wire frame. To apply, the burrs are removed and the sharp edge removed from the shaft. The coupling, with the rollers in the largest part of the chamber, is then slipped over the end. Turning in either direction forces the rollers up the inclined sides of the eccentric chamber and locks the case or cylinder tightly to the shaft.

FIG. 1. PULLEY WITH ROLLER BUSHING

The manner in which this is accomplished is shown in Fig. 1, which illustrates a pulley with the eccentric chambers in the bushing instead of in the pulley hub.

Fig. 2 shows a lineshaft with a coupling, a collar and a pulley in position. This shows how the roller grips the shaft. The absence of screws, bolts and pins makes it possible to put the couplings on without tools.

It is claimed that at least 40 per cent. of the driving power in reverse is necessary to unlock the rolls, but that this is easily accomplished when necessary by using the largest pulley on the shaft as a lever. After unlocking, a pointed pin, driven in the cross-hole in center, unlocks the driver. The smooth exterior insures freedom from accident caused by employees' clothing being caught on projections. These couplings are made by the Automatic Shaft-Coupling Co., Washington, D. C.

Motor-Speed Control

The smoothness of acceleration obtainable when starting a motor by means of a rheostat that graduates the voltage applied to the armature circuit depends on the number of steps available for cutting in and cutting out the rheostat resistance. The ideal rheostat is of the liquid type, because the movement of its variable element may be continuous. There are some applications, however, to which rheostats of the liquid type cannot conveniently be applied, and a sectional type of rheostat that would approach the equivalent liquid type in the matter of gradual voltage variation would cost too much.

The smoothest medium of graduation of the voltage applied to the starting of a motor is a rheostat in the field of the generator that supplies the energy for operating the motor. In most cases, however, this method is impracticable because variation of the generator voltage will affect the operation of all devices that depend upon that generator for energy.

In the cases of self-contained units in general and of gasoline-electric cars in particular, this objection does not hold, and almost ideal voltage variation control and motor acceleration are obtainable. The secret of the smooth acceleration lies in the fact that, owing to the self-induction of the generator fields, the generator e.m.f. cannot instantly respond in full to a change in the resistance of the generator-field circuit. As an illustration, assume the generators and motors permanently connected, and that the engine and generator are up to speed, but the field circuit of the generator open. On closing the generator-field switch, the generator field will pick up promptly, but in a continuously graduated manner, the rate of which will depend on the amount of resistance in the generator-field rheostat and on the resistance of the external, or motor, circuit. Simultaneously, the voltage applied to the motor circuit continuously increases from a minimum dependent on the amount of residual magnetism of the generator to the maximum value due to full excitation, if the speed corresponding to that excitation be desired. If the car be running at a

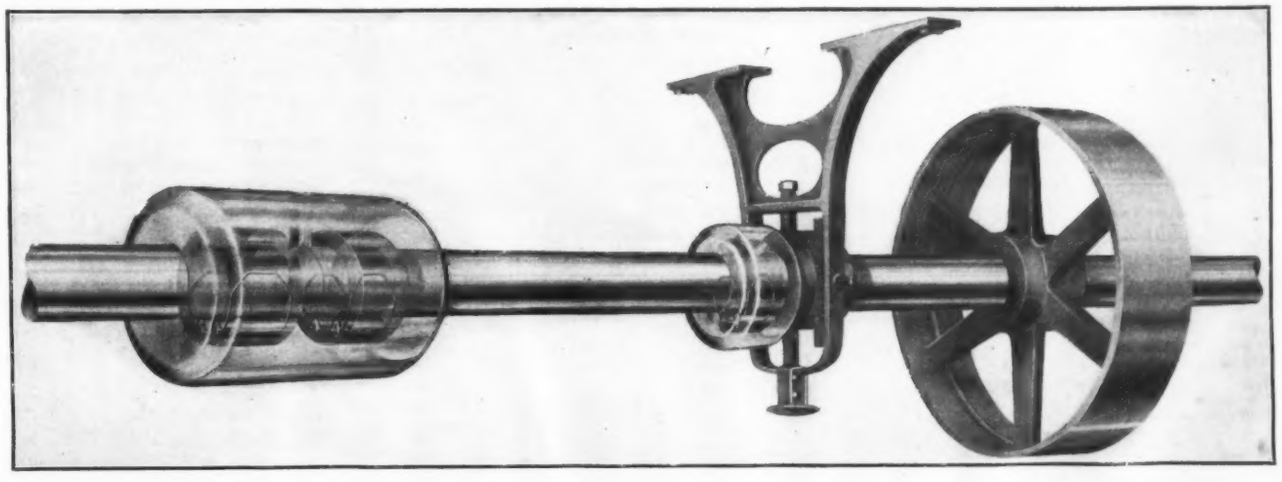


FIG 2. SHAFT COUPLING, SET COLLAR AND PULLEY BUSHING

certain speed and it is desired to run at some other speed, a change in the generator-field rheostat, in either direction, will not have its whole effect instantly or even impulsively, because neither the generator-field current nor the magnetism dependent on it can respond instantly in full. There is not enough hesitation to constitute appreciable delay, but there is enough graduation to convert into a continuous acceleration what otherwise would be an impulsive acceleration.

Owing to this unavoidable, as well as highly desirable, cushioning effect due to self-induction, there becomes available a much higher rate of acceleration that is free from the discomforting effects that characterize attempts to secure rapid acceleration by other means; and to get a given degree of smoothness of acceleration does not require a rheostat with as many sections as other methods would require.

"Ulcoloy" Bearing Metal

The United Lead Co., 111 Broadway, New York City, has recently brought out "Ulcoloy," a copper-lead metal for bearings, bushings and metallic packings. It is said that this metal can be remelted and molded over and over again without losing any of its inherent properties. It has the anti-friction properties of lead, combined with the strength and high melting point of copper. It is supplied in pigs convenient for melting.

When used as metallic packing, it is suitable for superheated steam. It can also be employed for piston rings, bull rings, etc. It is an acid-resisting metal and can be used to advantage for pump valves where acids are handled.

High-Resistance Pyrometers

A new line of high-resistance thermo-electric pyrometers for temperatures up to 3000 deg. F. is being placed on the market by the Bristol Co., Waterbury, Conn. The millivoltmeter movements of these new instruments are of the pivot-jewel-bearing dead-beat type, and are made by the Weston Electrical Instrument Co., especially for use with thermocouples. The pyrometers may be used with Bristol patented base-metal couples for measuring temperatures up to 2000 deg. F., and with standard platinum platinum-rhodium couples or compound couples with platinum platinum-rhodium tips for measuring temperatures up to 3000 deg. F.

The resistances of these instruments, designed for portable and switchboard use, are so high that the changes of resistance in the standard platinum couples are an extremely small and negligible percentage of the entire resistance of the circuit. Therefore, there are no appreciable errors due to ordinary changes of resistance in the circuit. They may be used under varying atmospheric temperature conditions and interchangeably with leads of various lengths within certain limits.

When calibrated for a scale range of 3000 deg. F. for use with platinum couples (or a range of approximately 18 millivolts) each of the instruments has more than 100 ohms resistance, and the temperature error is consequently less than 1 per cent. for a change of 25 deg. F.

When calibrated for a scale range of 2000 deg. F. for use with base-metal couples (or for a range of approximately 65 millivolts) the resistance of the instrument would be upward of 350 ohms and the temperature error would consequently be less than 1 per cent. for a change of 75 deg. F. This extremely high resistance makes these pyrometers practically independent of length of leads and length of couples.

The high sensibility of the instruments also makes them available for low ranges of temperature, where an open scale is required. They are provided with zero adjusting devices which afford a simple and quick way of adjustment for different "cold-end temperatures," and as the movements are of the pivot-jewel-bearing type, they are not affected by ordinary vibrations in shops.

The switchboard model is provided with a normal index that can be set at any desired point on the scale. The portable model weighs about 6 lb. It does not have to be leveled carefully in order to obtain an accurate reading. Both are provided with dustproof cases, and the wall-type can be used without any extra protection case. They are practical pyrometers for commercial and shop use, having a high degree of accuracy, and they may be used with flexibility.

"No-Spark" Carbon Brush

One of the annoying difficulties experienced in operating direct-current motors or generators is the lack of contact between the surface of the commutator and the brushes. This generates heat, causes sparking and cutting, and results in loss of power and wear of the commutator.

NO-SPARK CARBON BRUSH

The "No-Spark" carbon brush illustrated herewith is saturated with a lubricant that makes the brush contact practically frictionless, increases the conductivity of the carbon, and reduces the wear on the commutator. This brush wears smooth, takes a high polish and produces satisfactory operation all around. It is made by the Calebaugh Self-Lubricating Carbon Co., 1503 Columbia Avenue, Philadelphia, Penn., and distributed through jobbers.

Recuperating Dry Cells—Dry batteries sometimes become exhausted long before the outside covering of zinc has been eaten through. The failure is caused either because the chemicals have lost their strength or because the moisture has evaporated through cracks in the top covering of pitch. It is easy to renew the life of such batteries. Punch several holes through the top with an awl or long nail. Drive the tool in as deep as possible, but be careful not to break the carbon rod that runs the whole length of the battery. Dissolve in water several ounces of sal ammoniac, which can be purchased at any drug store, and pour the solution through the holes that have been made. Do this several times, so the solution will soak into the pores. After the battery has taken up all the solution it will hold, plug the holes with bits of cloth soaked in the sal ammoniac solution and seal the top with melted pitch or resin. The battery should then work nearly as well as when it was new. Another way to make dry batteries useful to the limit of their capacity is to punch holes in the zinc cover and put the entire battery into a jar of sal ammoniac solution. A battery so treated will continue to produce power as long as even the smallest particle of the zinc remains.—Exchange.

Your Education Is Never Over: a trade is never learned; no man can digest his business, and it is even hard to keep up with it.—"Graphite."

Editorials

Two Years of Boiler-Explosion Reports

Elsewhere in this issue is given a list of boiler explosions reported as occurring in the second half of 1914. In January, 1913, POWER commenced to secure information on this subject. The present list therefore marks the completion of two years' work. In the following table the data collected during these two years are summarized:

	1914			
	Second Half	First Half	Total	1913
Failures	255	320	575	501
Killed	80	120	200	173
Injured	217	240	457	391
Losses, No. reported.	73	80	153	120
Total value	$86,000	$246,000	$332,000	$211,000
Average value	$1,180	$3,080	$2,160	$1,760
Maximum value	$20,000	$100,000	.....	$40,000
Tube failures	38	60	98	107
C.-I. header failures.	8	30	38	6
Blowoff pipe failures	18	17	35	22
Domestic boilers	65	52	117	48
Portable boilers	17	4	21	19

In view of the conditions under which the data are gathered, only general conclusions can be drawn from the results obtained. They show, however, that the failures, killed and injured in the second half of 1914 were fewer than those given for the first half, although the totals for 1914 are considerably greater than those for 1913.

As regards data for power-plant boilers, tube failures decreased slightly in the later year, but the failures of cast-iron headers show a considerable increase, particularly in the first half of the year. The number of blowoff-pipe failures was much greater in 1914, showing that they should be more closely watched for any deterioration.

In a review of an earlier explosion list we stated that cast-iron, or domestic, boilers are shown to be frequently neglected or mismanaged and that they should receive closer inspection and supervision. The fact that accidents of this nature more than doubled in 1914 shows that this warning deserves serious consideration. The term "domestic" is here taken to include all cast-iron heating, hot-water heating, kitchen ranges and other boilers used for strictly domestic purposes.

The totals are also given for portable boilers such as are used in hoisting engines, oil drills, traction and threshing machines. The number recorded is practically the same for 1914 as for 1913, although the number for the second half of 1914, as would naturally be expected, is much the greater. An examination of the causes given for the failures of portable boilers indicates that a large number failed from old age, corroded shells and similar causes, showing the need for more careful inspection of this type of apparatus.

There still seems to be some misunderstanding regarding the use of the word "explosion" in the preparation of these lists. The term is used in the strictest technical sense to cover any unintentional escape of the contents of a pressure vessel. The effect need not be total destruction or dislodgment of the containing vessel. While the report is not as complete as we would like to have had it, it represents all the facts obtainable. It is to be hoped that in the future the still greater coöperation of our subscribers will enable us to continue this work so that the conclusions drawn from the list will be of more value.

Plea for Automatic Stop Valves

Just suppose, Mr. Boiler Owner, that the trolley cars in your town did not have guards at the windows; that the train on which you commute used no signal system; that the steamer on which you occasionally ride had no small boats or life preservers; that the hotels at which you stop had no fire escapes; that the elevators in your business associates' buildings had no "safeties"—just suppose that all these and more of the protective measures and devices you are accustomed to were lacking. Would you excuse a serious, not to say fatal, accident because any of these were lacking? Of course not. You would condemn the accident as inexcusable and punishable to the law's limit, because all these and other safety devices are available in the open market at prices not prohibitive.

So are automatic stop valves. And by the same reasoning the consequences of a boiler accident preventable by the timely installation of automatic stop valves are inexcusable. These valves not only greatly lessen the danger of scalding those in and near the danger zone when a tube lets go or a steam pipe bursts, but their use prevents steam being turned into a boiler in which, perhaps, men are working. They will not open to cut in a boiler on the line until the pressure is slightly more than the line pressure.

One recalls with a shudder the horrible accidents aboard the "Alamo," "Delaware," "Sonoma," "Principe de Piedmonte," "Jefferson," "Bennington" and other vessels. The terrible toll of life these accidents took would have been greatly lessened if automatic valves had been used. On land the accidents which were preventable, or the seriousness of which would have been considerably diminished if automatic valves had been used, are many and they continue.

It takes a nerve of iron to find one's way through scalding, blinding steam to the top of a boiler and shut the stop valve when a tube or the steam line has burst. Few men ever do it. With automatic valves available, no reasonable person would expect or order a man to do it. Although, so far as this paper knows, there is no precedent by which to conclude, it is questionable if in a suit for damages for injury or death under such circumstances a jury or court would favor the plaintiff. The good to be done by assuming such a risk or the need of assuming it rarely, if ever, warrants the performance of such a self-evident hazardous act, however much the heroism may stir the emotions.

Humanitarian considerations of safety are by no means all that should commend automatic stop valves to boiler owners. They do more than minimize death and injury. They save money, the amount of which depends upon the

establishment's output, by preventing a complete shutdown because of loss of steam in all boilers when only one is damaged.

Where many people are employed and the output is large, such enforced idleness causes a loss greatly exceeding the cost of valves. If the accident results in the installation of such valves, the owner may correctly consider that the total cost of the installation is the cost of the valves and labor plus the loss occasioned by the shutdown. So a timely investment in these is a form of insurance that alone should make every boiler owner eager to use them, to say nothing of their service as safety devices, although under employers' liability acts and workmen's compensation laws, they are insurance to employers against loss from injury and death.

The use of these valves on large steam lines to prime movers meets with approval, but there is an impression that they are so sensitive as to close during a sudden, heavy demand for steam and shut the engine down when its services are most needed. This is probably a matter of adjustment and adaptation.

The advantages of these valves are so numerous and important that even boiler owners cannot but reach the conclusion that they should not defer their adoption until the law compels their use, as it surely will some day in every locality.

Concerning Directors

Not a few young engineers look upon their company's directors as gouty old "tightwads" whose views are worthless when bearing upon the engineering policy of the plant. True, most directors of large industrial concerns using power, and even of many producing and selling power, have little appreciation of the expert side of engineering. Raising money and safeguarding the financial interests of the stockholders are their long suits, and plenty of them do not know a generator from a turbine. Too many of them never visit the power plant or else only perfunctorily, on an annual tour of inspection. Nevertheless, if the young engineer thinks that his attitude toward the board, their interest in his work, and his opinion of the abilities of these gentlemen are of little consequence, he is making a big mistake.

In his early experience, after attaining to some authority and influence, the engineer is likely to be annoyed by having his recommendations turned down by the directors. These recommendations may be entirely sound technically and desirable as the engineer sees it, but may fail to pass at the board meeting, where hard-headed financiers look at all sides and feel their way carefully before authorizing new expenditures.

In such a case the engineer should not cultivate a "grouch." When he has worked out a problem of this kind and convinced himself that he has the best solution, his duty is done if he presents it to his superior, backed up by facts and figures. Sometimes these buried recommendations are resurrected, conditions change, memberships on the board are altered, and so on, so that time often brings its own justification. Sometimes, also, the efficient and cheerful work of the engineer has been noted by one or two directors unknown to himself, and they have been the means of the advancement of the engineer by transfer or promotion.

None of these comments excuses ignorance on the part of directors of the affairs for which they are responsible, but because these people are not thoroughly posted on the technical problems of the engineer is no reason whatever for relegating their opinions to the discard. We venture this caution to the technical graduates of 1915 about to go into power-plant work, for the temptation on the part of highly trained technical men fresh from school to deprecate financial ability as compared with scientific acumen is too strong to be indulged.

The Value of a Cool Head

Operating engineers do not need to be told the importance of coolheadedness in handling emergencies, but specific cases press home the lesson of mental self-control now and then in a way that deserves emphasis.

In the construction of a brick chimney recently at the United States Naval Hospital, Chelsea, Mass., a block gave way in a hoist, the faulty pulley being on the ground at the foot of the stack. Two horses were pulling up a load of material by a rope passing around the block and running to the top of the stack, where it ran around a second block before leading to a heavy bucket in which the material was raised. The failure of the block on the ground caused the rope to tighten, put a heavy strain on the green brick and mortar setting at the top of the stack and broke off a section, throwing two men to the ground, with fatal results. The third man, left on the weak top and too far above the earth to be reached by the longest extension ladders of the local fire department, kept his nerve, though one of the victims was his brother. He could not trust his weight to the newly set rungs of an iron ladder near the top of the stack, but with quiet patience knocked bricks from the upper portion of the chimney, gradually working his way downward until he reached a firmly set section of the ladder, after which he climbed down to safety. The feat was one which any engineer might turn to account if caught in a like predicament, and emphasized the value of a cool head in a way not soon to be forgotten by the witnesses.

Looks as though England is going to be shy a few heat units at the end of this year. If the falling off coal output continues at the present rate, it is estimated that this year's shortage will be thirty-six million tons. At twenty-seven million heat units per ton the heat value would be 972,000,000,000,000 B.t.u., an equivalent of 756,216,000,000,000,000 foot-pounds.

Beware of any accumulation of vapor from even the heavier oils, especially when such accumulations may be in a confined space. In the days when kerosene was in favor as a scale resolvent, many a boiler cleaner got singed—or worse—by putting a torch or a candle to the boiler or heater which was open for cleaning. Even an electric bulb may not be used with impunity. The engineer of an Oklahoma ice plant put a barrel of crude oil into one of his boilers, slowly filled the boiler with water, allowing the oil to rise and bathe all the surfaces, and then drew the water off, giving the oil a chance for a second coat. As the process proceeded he climbed upon the boiler, stuck an extension lamp into the manhole, and a bare spot upon the wire struck a spark. His widow is now suing for $30,000.

Correspondence

Auxiliary Exhaust Valves on Uniflow Engines

Two diametrically opposed opinions as to the relative merits of auxiliary exhaust valves on uniflow* engines have recently appeared in the technical press. Authorities seem agreed that these valves are of little value, if not an actual detriment, on condensing engines, just as long as the vacuum is maintained. The dispute affects engines for noncondensing service and the value of the valves as a safeguard against accident, due to excessive compression, should the vacuum be broken in condensing service. Such a safeguarding feature is undoubtedly a strong argument in their favor, but the important consideration is really their value in noncondensing service, for other safety devices can be installed to protect condensing engines against undue increase in compression.

Professor Stumpf, to whom must be credited the commercial success and development of the "una-flow" engine, makes the statement: "Even when used for noncondensing service, with steam pressures as used in modern power plants, auxiliary exhaust valves show no gain." Mr. Skinner, to whom the excellent record of the "Universal Unaflow," engine is largely due, takes the opposite stand and credits the economy in steam consumption of his engine to the fact that auxiliary exhaust valves are used. Mr. Turnwald, who was associated with Professor Stumpf during the introduction of the "unaflow" engine in Germany, endeavors to solve the dispute by the remark: "The engine with auxiliary exhaust valves must be more efficient at low steam pressures and high back pressures, and the engine without auxiliary exhaust valves must be more efficient at high pressures and low back pressures."

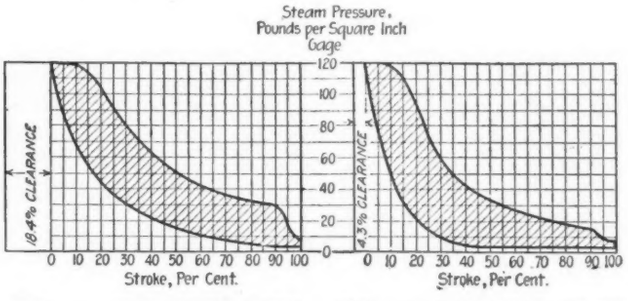


FIG. 1. DIAGRAM FROM UNAFLOW ENGINE WITHOUT AUXILIARY EXHAUST VALVES

FIG. 2. DIAGRAM FROM UNAFLOW ENGINE WITH AUXILIARY EXHAUST VALVES

Mr. Turnwald's explanation, even if correct, is not entirely satisfactory, for it recommends the use of engines without auxiliary exhaust valves under favorable conditions and leaves the more trying service of unsatisfactory steam pressure and poor exhaust conditions to be cared for by the engine with the auxiliary exhaust valves. When, then, do a plant's operating conditions become sufficiently favorable to justify the use of engines without auxiliary exhaust valves? Mr. Turnwald states that curves representing the respective efficiencies of the two constructions cannot yet be accurately determined, but from data now available they should cross somewhere between steam pressures of 120 and 150 lb. at atmospheric exhaust. These limits lie well within present-day practice, so the question of which type to use promises to remain unsettled, notwithstanding the explanation.

Auxiliary exhaust valves have but one object, to delay commencement of compression by ridding the cylinder of more of the expanded steam than can escape through the central exhaust ports. This allows a reduction in the amount of final clearance that has to be provided. A certain degree of compression is necessary to keep the engine from pounding, and this must be the same whether auxiliary exhaust valves are employed or not. To just what degree the compression must be carried depends upon the proportions of the engine. Data secured from a particular engine can be of little general value, as the advisable degree of compression must vary for nearly every engine; the rotative speed remaining the same, it should depend largely upon the weight of the moving parts.

Delayed compression simply concentrates the work toward the end of the stroke; the energy to be overcome is just as great no matter when compression is commenced, provided the mean effective pressure remains the same. Of course, with a late compression and a corresponding reduction in the quantity of steam to be compressed, the less the amount of work required to reach the required pressure. It is this fact that led to the introduction of auxiliary exhaust valves on uniflow engines, the work of compression developing no useful power, its reduction seemed desirable.

In confirmation of this theory, Mr. Skinner compares indicator diagrams from engines with and without auxiliary exhaust valves that show the same indicated power output; these are reproduced in Figs. 1 and 2. Both show that compression is carried to practically admission pressure. In the engine without auxiliary exhaust valves, the necessary clearance is 18.4 per cent., while for the engine with such valves, the required clearance is but 4.3 per cent. Obviously, the work entailed in compressing the charge in the former engine is more than four times as great. To secure the same indicated power output (the two indicator diagrams being of equal area), Mr. Skinner states that more steam would have to be admitted to the cylinder, cutoff would occur later in the stroke, release occur at a higher pressure and less expansion take place than in the case of the engine with auxiliary exhaust valves. That the release would be higher and that there would be less expansion is unquestionably true, but why the cutoff should necessarily take place later in the stroke, with accompanying increase in the amount of steam, is not so clear.

*For distinction between uniflow and unaflow, see "Power," Feb. 19, 1915, page 201

Fig. 3 shows the diagrams of Figs. 1 and 2 superimposed, the lower cross-sectioned area representing the extra work required for compression in the case of the engine without auxiliary exhaust valves, and the upper cross-sectioned area, the power to be added to that represented by the common area to bring the output up to that of the engine with auxiliary exhaust valves. The higher release and the decrease in expansion of the engine without auxiliary exhaust valves is clearly indicated, as is also the fact that in both engines expansion commences before cutoff takes place and is fairly well advanced by the time that the admission of steam is arrested. With a much larger volume of steam, at practically admission pressure, entrapped in the compression space of the engine without auxiliary exhaust valves, expansion cannot be as far advanced at cutoff as in the engine with the auxiliary exhaust valves. In other words, the actual pressure exerted against the piston at the cutoff must be greater in the case of the engine without the auxiliary exhaust valves, although the effective pressure is less. In fact, throughout expansion, the

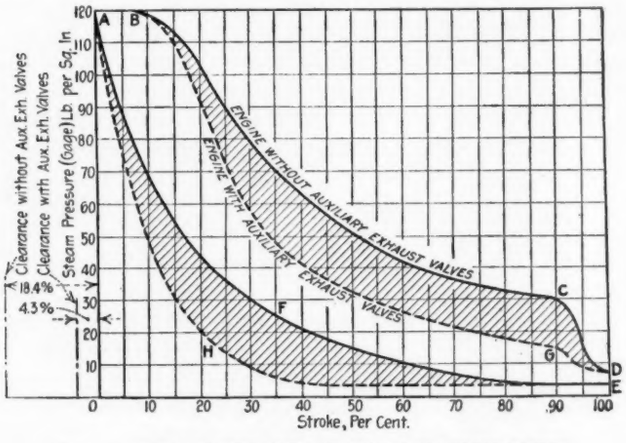


FIG. 3. INDICATOR DIAGRAMS SUPERIMPOSED

actual pressure against the piston must be greater in the engine without auxiliary exhaust valves, owing to the greater volume of steam in the cylinder. This, and not the suggestion that cutoff must take place later in the stroke and more steam be admitted to the cylinder, accounts for the fact that the expansion curve lies above that of the engine with auxiliary exhaust valves, that the release is at a higher pressure in the former engine and that the expansion is less.

Fig. 4 shows the value of the effective steam pressure on the pistons of the two engines throughout the working stroke, that is, the difference between the actual pressure on the piston and that expended in compression. The areas below the respective curves are practically the same, showing that the mean effective pressure is similar; but the distribution of pressure on the pistons is quite dissimilar, being greater in the case of the engine with auxiliary exhaust valves during the first 30 per cent. of the stroke and becoming proportionally less and less from that point until the central exhaust ports begin to open, at about 90 per cent. of stroke and at the point where compression in the engine without such extra valves begins on the return stroke. During the last 10 per cent. of the working stroke, during the release, the effective pressures on the pistons gradually become more similar until they are the same at the end of the stroke.

It would seem that the actual power developed by the two engines is not the same, owing to the great dissimilarity in effective pressures on the pistons.

With lower steam pressures the difference would not be so marked, but the effect of increased back pressure should

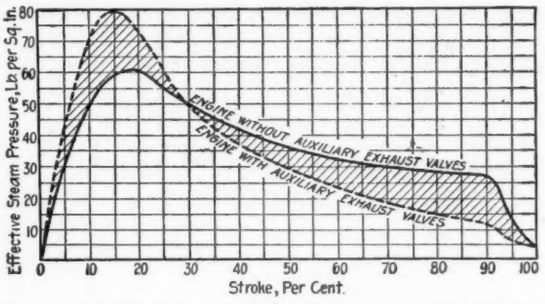

Effective Steam Pressure, Lb. per Sq. In.
ENGINE WITHOUT AUXILIARY EXHAUST VALVES
ENGINE WITH AUXILIARY EXHAUST VALVES
Stroke, Per Cent.

FIG. 4. EFFECTIVE STEAM PRESSURE ON PISTONS

be even more harmful in the engine with auxiliary exhaust valves than in the one in which the release takes place while the steam is under higher relative pressure. In the engine in which the expansion is not carried so far, an increase in back pressure reduces the pressure on the piston by no greater an amount than would similar pressure reduce the push on the piston of an engine in which the expansion is carried farther, but the effective pressure on the piston being greater, the proportionate loss must be less.

The indicator diagram of the engine without auxiliary exhaust valves is not, it is true, an ideal one, on account of the comparatively high release brought about by the length of compression. In this respect, the Skinner engine has the decided advantage, but if there is a loss in economy in steam consumption also due to the shorter compression, the less ideal diagram would seem to be the more desirable to attain.

REGINALD TRAUTSCHOLD.

New York City.

Glendale Municipal Electric Lighting Plant

An interesting example of effective and highly profitable municipal-plant operation is evidenced in the electric lighting and power station of the City of Glendale, near Los Angeles, Calif. The electric-light department of this municipality was organized in 1909, acquiring the small central station then in operation and serving a total of about 200 local consumers. With the growth of the city during the past six years, the plant has been augmented and converted into a station for the transforming and distribution of high potential energy obtained from an outside source. The plant has a present valuation of $150,000 and renders service to over 2700 consumers.

The total issue of bonds for building and equipment has reached $100,000. These are being rapidly retired from the surplus earnings of the station which, entirely self-supporting, directly handles the interest and redemption of this bonded debt. Electric energy at 15,000 volts is purchased from the Pacific Light & Power Corporation, of Los Angeles, and is reduced to commercial voltages for local distribution.

Increased earnings have led to decreased rates for service, affording residents of the city an opportunity

to share in the prosperity of the plant. The charges for electric lighting have been reduced from year to year until the following basic rates have been adopted, these being recently inaugurated: The first 20 kw.-hr., 7c. per kw.; next 14 kw.-hr., 5c.; and all over 34 kw.-hr., 3c. per kw. The minimum charge is 50c. per month.

The accompanying statement of operating revenues and expenses, lately issued by H. B. Lynch, plant manager, sets forth in detail the efficient and economical operation of this municipal enterprise, covering all features of the service in which the station engages. It is particularly interesting by reason of the profitable attainments attending the wholesale purchase of electric power and the redistribution in the form of metered service for local consumption.

REVENUE		OPERATING EXPENSE	
Commercial lighting	$38,924.54	Wages and material	$4,908.12
Commercial power..	3,873.18	Power purchased...	15,004.10
Street lighting.....	5,714.33	General expense....	4,224.15
Miscellaneous revenue	2,875.75	Commercial expense	2,984.60
		Depreciation	6,698.64
			$33,909.61
		Profit from operation for year.....	17,478.19
	$51,387.80		$51,387.80
Profit from operation for year.....			$17,478.19
Less interest for year.....			5,145.87
Net profit for year.....			$12,332.32

The lighting department aims to give the best possible service. It not only tries to fulfill all lighting contracts satisfactorily, but it also seeks to engage the coöperation of those it serves. It encourages outside suggestions that will help to obtain the best results, making the consumer feel that he is a vital part in the operation of the plant.

L. R. W. Allison.

Newark, N. J.

The Brushes Broke

Among the factors that influence commutator wear are: Condition of commutator, amount of end-play, relative hardness of the commutator and of the brushes, amount of brush tension, speed, vibration, commutation, presence of foreign particles or of other abrasives, and number of brushes tracking over the same zone of the commutator. The factor of interest here is the last-named.

An operator complained that his motor brushes were breaking at the rate of three or four a day on two motors. Someone had told him that vibration was the cause; so, at considerable expense, he had shored the floor under the motor until vibration was negligible. The brushes continued to break, however, because the trouble was in the middle zone of the commutator, as was indicated by the fact that all the middle brushes, of which there were eight, vibrated badly while their holders did not vibrate at all. The slotted commutator appeared smooth, but it was removed from the machine and a light cut taken off. The trouble disappeared, but began to reappear in a few days and was temporarily relieved by sandpapering. The motor was of the repulsion-induction type and had two sets each of compensating and of energy brushes. Alternate brushholder studs had two and three brushes per stud and the holders were so set that eight brushes tracked the middle zone of the commutator, while only six tracked the outside zones. On two of the studs that had two holders per stud, one brush of each was so shifted as to give but six brushes tracking the middle zone and seven each outside zone. The brush tensions were then equalized and at the end of two months there were no indications of breakage trouble again developing.

The motors were operating at especially high speeds and the least roughness of the commutator was greatly magnified.

E. C. Parham.

Schenctady, N. Y.

Iron Bars as Aid to Combustion

Referring to the letter, "Another Combustion Suggestion," by A. P. Connor, on page 856 of the June 22 issue, I do not know what the "analogous arts" are to which he refers, but if he will investigate the subject he brings up he will find engineers are wide awake in this matter.

The use of iron rods is unpractical for a number of reasons. Iron rods in contact with a hot fire would soon melt and probably weld the grates. If this trouble could be obviated, it would be impossible to put a leveler or other firing tool in the fire. Also, considering the fact that fires get thicker, it would compel adjusting the level of the bars to suit the thickness of the fire. The use of hollow tubes would be still more objectionable.

The second principle is used in a somewhat different manner than that suggested by Mr. Connor. Instead of mixing with the fire materials that do not burn, a brick arch is built over the fire and tends to hold the furnace temperature uniform and insure the complete combustion of the volatile gases given out from the green coal when first fired. Dutch-oven furnaces are built with the idea of providing for complete combustion of the gases before they strike the comparatively cool surfaces of the boiler. The success of underfeed stokers is primarily due to the fact that the furnace conditions are always uniform while operating, as the coal, being fed from underneath, has its volatile products distilled, and as they pass upward they are heated and burned at a maximum temperature by the incandescent coke on top of the fire.

Warren D. Lewis.

Brooklyn, N. Y.

Putting a New Engine on an Old Foundation

About a year ago we saved considerable expense by installing a 17x18-in. Ridgway engine directly connected to a 150-kw. generator on an old brick foundation.

The template was laid on top of the old foundation and the bolt holes marked. Holes were drilled 3 in. in diameter and 3½ ft. deep with a star drill. Grooves were then cut 6 in. deep and 12 in. wide on the old brickwork, and 6 in. of new brick added, as the old foundation was not high enough. The bolts were then set in with washers ½ in. thick and 2¾ in. in diameter dropped over them to take the place of plates generally used. The engine was then placed on the foundation and leveled up with wedges, and before the engine was tightened down a thin grout of neat cement was poured under and allowed to set 36 hours. It has run 24 hours per day for 7 months and is in perfect condition.

Fred K. Ginther.

Leetonia, Ohio.

Inquiries of General Interest

R. H. and L. H. Sides of Duplex Pump—Which is the right-hand side and which the left-hand side of a duplex pump?

W. P.

Standing at the steam end and facing the water end of the pump, the side on the left is designated by manufacturers as the left-hand side and the one on the right as the right-hand side.

Boiler Capacity for Heating Factory Buildings—What general rule can be employed to determine the boiler capacity required for heating factory buildings?

J. S.

For factory buildings of ordinary construction a good general rule is to allow one boiler horsepower per 10,000 cu.ft. of space, based upon the outside dimensions of the buildings.

Pressure of the Atmosphere from Height of Barometer—Knowing the height of the barometer, how may the pressure of the atmosphere be known in pounds per square inch?

C. W.

A column of mercury at 62 deg. F., and one inch in height, balances a pressure of 0.4912 lb. per square inch, and the pressure of the atmosphere in pounds per square inch may be closely approximated for ordinary temperatures by multiplying the height of the barometer in inches by 0.491.

Benefit of Overtravel of Valve—What is the benefit of overtravel of a valve?

F. H.

In engines with fixed eccentrics, the only benefit of overtravel is to increase the sharpness of the cutting off. In engines with link-motion valve gears and shifting-eccentric engines, the travel of the valve is shortened at the early cutoffs; and in such engines, in order to secure sufficient port opening at the early cutoffs, it is necessary to give overtravel with the late cutoffs.

Correction of Heating Estimates for Wind Velocity—In estimating the heating of buildings what correction of the outside temperature should be made for wind velocity?

A. A. R.

With ordinary building construction and an outside temperature of 40 to 15 deg. F. above zero, each mile of wind movement per hour may be regarded as equivalent to 1 deg. drop in temperature; from 15 deg. above zero to 20 deg. below, each mile of wind movement per hour may be taken as equivalent to 1.15 deg. drop in temperature.

Why Steam Tables Are Based on Absolute Pressures—Why do not steam tables quote the properties of steam for different gage pressures in place of absolute pressures?

B. R.

The temperature and other properties of steam such as given in the steam tables depend upon the absolute pressure, or pressure above a perfect vacuum, and as ordinary pressure gages can only indicate pressures above or below the atmosphere, which is variable, a table based on gage pressures would be true for only a particular pressure of the atmosphere.

Heat of Combustion of a Cubic Foot of Gas—What is the heat value for the complete combustion of a cubic foot of gas consisting of hydrogen 12 per cent., methane 70 per cent. and benzole 18 per cent.?

J. C. N.

A cubic foot of the gas, measured at standard temperature and pressure (32 deg. F. and 29.92 in. of mercury), in complete combustion would yield

For the hydrogen	(H_2),	0.12 of 342 B.t.u.	=	41.0 B.t.u.
For the methane	(CH_4),	0.70 of 1012 B.t.u.	=	708.4 B.t.u.
For the benzole	(C_6H_6),	0.18 of 3868 B.t.u.	=	696.2 B.t.u.
Total				1445.6 B.t.u.

Lap of Steam Valves of Duplex Pump—How much lap is proper for the steam valves of a duplex pump?

C. B.

The steam valves are usually provided with no more inside or outside lap than necessary to cover any irregularities of the edges of the ports, as any additional lap would increase the possibility of having the valves stop in a position where all ports are covered, from which position the pump could not be started. By giving little or no lap this danger is practically obviated, since there is only one point of the stroke where the piston must stand to have all ports covered, and both pistons would have to stand at their respective dead centers at the same instant.

Returning Condensate from Separator—Can the condensate discharged from a steam separator of an engine be returned to a boiler by its own gravity?

C. A.

The condensate can be so returned only when the point of discharge from the separator is sufficiently elevated above the water line of the boiler for the hydraulic head, plus the discharging pressure, to be in excess of pressure lost in pipe friction, plus the pressure carried in the boiler. In most plants the elevation of the separator above the boiler is not sufficient to secure more than a few pounds' pressure from the hydraulic head, and as unusual drafts of steam are likely to reduce the discharge pressure from the separator, dependence cannot be placed on direct gravity return of the condensate to the boiler. A separator on a steam line to a pump or engine should be relieved of water by a trap discharging to a receiver, or by a steam loop or return trap for returning the condensate to the boiler.

Current Required for Centrifugal Pump—What electric current would be required to elevate 600 gal. of water per min. with a centrifugal pump of 67 per cent. efficiency working against a head of 280 ft., which includes the suction lift and friction loss in the suction and discharge pipe, using a 550-volt, direct-current motor of 90-per cent. efficiency?

T. H. P.

The useful work, or work performed in lifting the water, would be

$$\frac{600 \times 8.33 \times 280}{33{,}000} = 42.5 \text{ hp.}$$

and with 67 per cent. efficiency the actual power applied to the pump would be

$$42.5 \div 0.67 = 63.43 \text{ hp.}$$

As the efficiency of the motor is 90 per cent. and as one electric horsepower is equivalent to 0.746 kw., the electric power required would be,

$$\frac{63.43 \times 0.746}{0.90} = 52.5 \text{ kw.}$$

The current required would be

$$\frac{52.5 \times 1000}{550 \text{ volts}} = 95.4 \text{ amperes.}$$

Working Pressure for Shell of Drum—With a factor of safety of 5, what would be the maximum working pressure allowable for the shell of a steel drum 42 in. diameter, having shell plates ⅜ in. thick and tensile strength of 58,000 lb. per sq.in. of cross-section, and having butt and double-strap longitudinal joints, double-riveted, with an efficiency of 74 per cent. of the strength of the solid plate?

C. P. E.

The maximum allowable working pressure as limited by the strength of the shell would be given by the expression,

$$\frac{T S \times t \times E}{R \times F}$$

in which

T S = Tensile strength, 58,000 lb.;
t = Thickness of shell plate, ⅜ in.;
E = Efficiency of longitudinal joint, 0.74;
R = Radius = one-half the inside diameter of the outside course of the shell = 21 in.;
F = Factor of safety, 5.

By substituting the given values the working pressure is found to be

$$\frac{58{,}000 \times \frac{3}{8} \times 0.74}{21 \times 5} = 153.3 \text{ lb. per sq.in.}$$

[Correspondents sending us inquiries should sign their communications with full names and post-office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Boiler Explosions During Second Half of 1914

Boiler Explosions During Second Half of 1914

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
July 1	Cleveland, Ohio	Hartman Provision Co.		Horizontal-tubular	118	100 hp.	0	1		Blow-off failed
July 1	Kokomo, Ind.	Hotel Francis		Cast-iron and water tank			0	0		Valves closed—no relief
July 2	Staser, Ind.	Dredge Boat	10:30 p.m.	Locomotive type	115	60 hp.	1	0	$2000	Low water
July 3	Galena, Ill.	J. A. M. Scott Mine					1	0		
July 3	Lexington, Ky.	Phoenix Hotel		Water-tube	110	250 hp.	0	0	$25	Three cast-iron headers failed
July 7	Omaha, Neb.	Omaha Light & Power Co.		Water-tube		500 hp.	0	0	$350	Defective tube ruptured
July 7	Leetown, Ky.	J. H. Lee Sawmill					1	2		
July 8	Concordia, Kan.	Bishop's Farm	9:00 a.m.	Locomotive type	120	15 hp.	0	1	$600	Low water
July 10	Camden, N. J.	Langston & Son		Cast-iron heating	30		0	0		Overpressure safety valve inactive
July 10	Jacksonville, Fla.	Chapman Carriage Factory	11:00 a.m.	Vertical			0	0		Over pressure
July 10	White Sulphur Springs, W. Va.	U. S. S. Hotel Co.		Water-tube			0	0		Seven cast-iron headers failed
July 11	Swastika, Ont., Can.	Tough Oaks Mine			120		1	1		Through rod, nut stripped
July 12	Troy, Ohio	City Pumping Plant	9:00 a.m.	Water-tube	150	90 hp.	0	0	$75	Cast-iron header failed
July 13	Bornaugh, Mo.	M. L. George's Farm					1	0		Old boiler
July 14	Worcester, Mass.	Worcester Cons. Ry. Co.	4:45 p.m.	Water-tube	195	1200 hp.	1	2		Tube failure
July 14	Wynne, Ark.	Wynne Stave Co.					0	1		Blow-off failed
July 14	Newark, N. J.	Public Service Corporation		Water-tube			0	0		Tube ruptured
July 16	Wenshall, Minn.			Steam shovel			1	0		
July 17	Belle Plaine, Ia.	Boody Dairy	2:00 p.m.	Vertical	20	22″x56″	0	3	$100	"Overpressure"
July 17	Philadelphia, Penn.	Sacred Heart Parish House		Cast-iron sectional			0	0		Sections failed
July 17	Aledo, Ill.		4:00 p.m.	Thresher engine	120	18 hp.	0	2	$600	Low water, sheets corroded
July 18	Barnesboro, Penn.	Madeira Hill Coal Co.					1	0		
July 23	Barham, La.	Pickenny Lumber Co.					0	1		
July 23	Oakville, Ont., Can.	Bronte Basket Factory	7:00 a.m.	Internally-fired	110	150 hp.	0	0		Lap seam crack in steam drum
July 25	Truro, N. S., Can.	Londonderry Pipe Shop.		Hot-water			0	0		Excessive pressure. Valve closed on supply line
July 27	Springfield, Mass.	Strong Bldg.		Traction engine			0	2		
July 27	New Castle, Penn.			Water-tube		400 hp.	0	0	$1186	Tube ruptured
July 29	Alpena, Mich.	Huron Portland Cement Co.	7:30 a.m.	Scotch marine	100	125 hp.	0	0	None	Tube blew out
July 29	Newburyport, Mass.	Pleasure-boat "Turtle"	7:00 a.m.	Threshing engine	90	16 hp.	1	0	$75	Corrosion of blow-off tank
July 30	Chicago, Ill.	Mallers Bldg.	12:40 p.m.	Scotch marine	90	60 hp.	2	2		Old engine
July 30	Monee, Ill.	Farm	10:00 a.m.	Water-tube	125	150 hp.	0	0	$500	Defective pipe connections
Aug. 1	Darien, Ga.	Altamaha Wood Working Co.	3:00 a.m.	Cross drum water-tube	175	400 hp.	0	0	$150	Tube ruptured—low water
Aug. 2	Austin, Texas	C. N. Avery & M. L. White Ice Plant	9:30 a.m.	Hot-water	nknown	30 gal.	0	0	$750	Gas explosion in furnace
Aug. 2	Lindsay, Calif.	Tulare County Power Co. .		Water-tube			2	1		Safety-valve failed
Aug. 3	Webster, Mass.	Alphonse Gaboury Bakery	8:00 a.m.	Return-tubular	100	72″ x 18′	0	1		Tube ruptured
Aug. 3	Ivorydale, Ohio	Proctor & Gamble	10:30 p.m.		95	60 hp.	0	1		Blow-off pipe failed
Aug. 4	Hamilton, Kan.	Hiawatha Electric Light Co.	4:00 p.m.	Traction engine		20 hp.	0	0	$3000	Unknown
Aug. 4	Unicorn, Penn.	Joseph P. Moore's Sawmill	11:00 a.m.	Vertical	110	10 hp.	2	3	$250	Safety valve inoperative
Aug. 5	Chicago Heights, Ill.			Threshing machine			0	1		Plug in place of tube failed
Aug. 8	Livermore, Cal.	Diamond Milling Co.		Water-tube			0	1		Low water
Aug. 8	Blue Springs, Neb.			Traction engine			0	1		
Aug. 10	Pittsburgh, Penn.	Duquesne Light Co.	9:00 a.m.	Horizontal-tubular	80	80 hp.	1	0		
Aug. 11	Ithaca, N. Y.			Water-tube			1	0		Leak only, no explosion
Aug. 12	Mount Vernon, N. Y.	Lorillard Refrigerator Factory		Vertical			0	0		Tube ruptured
Aug. 13	Youngstown, Ohio	Wm. Tod Co., Engine Manufacturers	Noon	Horizontal-tubular	125	20 hp.	0	2		Sheets corroded and wasted away
Aug. 13	Leipsic, Ohio	Well Drilling Rig	7:00 a.m.	Horizontal-tubular	100	72″ x 16′	0	0	$300	
Aug. 15	Chatsworth, Ill.	Kellman Brothers		Horizontal return-tubular	60	60 hp.	0	0	$100	
Aug. 16	Ashtabula, Ohio	Crystal Ice Co.	4:00 p.m.	Return-tubular	140	60 hp.	4	12	$300	Old age
Aug. 16	Dubuque, Iowa	I. Belsky Packing Co.		Return-tubular	80	2-75	0	0	$3000	Low water
Aug. 17	Letford, Ga.	Sawmill		Water-tube			1	0	None	Tube ruptured
Aug. 17	East Providence, R. I.	Naragansett Milling Co.					0	0		
Aug. 17	Monroe, La.	City Elec. Light & Power House	12 M.	Locomotive type	90		2	0		
Aug. 18	East Toronto, Ont., Can.	Toronto Dairy	11:30 a.m.	Locomotive type	130	30 hp.	1	2	$50	Mud filled the water lugs to level of grates
Aug. 19	Grampian, Pa.	Don. Miller's Shingle Mill		Small engine			0	3		Safety valve inoperative
Aug. 22	Ellsworth, Kan.	W. E. Sheriff's Farm	10:00 a.m.		80		0	0		
Aug. 25	Elgin, Ill.	Harry Leonard's Home					0	0		Over pressure
Aug. 25	Rochester, N. Y.	Mrs. C. H. Halsey Dairy		Water-tube			0	2		
Aug. 26	Weston, W. Va.	Malloy Bros. Ice & Bottling Works	4:45 p.m.	Return-tubular	95	48″ x 14′	0	20	$2000	Tube ruptured
Aug. 26	Jonesville, Mich.	Omega Portland Cement Co.	5:00 p.m.	Horizontal	40	20 hp.	1	1	$1500	Unknown
Aug. 26	Markham, Fla.	Zachary Lumber Mill					1	1		
Aug. 26	Churchtown, Penn.	Bowman's Cider Mill					0	0	$50	
Aug. 28	Smoketown, Penn.	Weaver Mill	3:00 a.m.	Water-tube	160	400 hp.	0	0	$200	Tube ruptured
Aug. 29	Cincinnati, Ohio	Cin. Sand Blast Co.		Water-tube			0	0		Tube ruptured
Aug. 30	Chicago, Ill.	Swift & Co., Union Stock Yards					0	1		
Aug. 30	Greensboro, N. C.	Proximity Manufacturing Co.	12 M.	Traction engine		20 hp.	0	0		Corroded boiler shell
Aug. 31	Philadelphia, Penn.	Dickson Paper Mills	Night	Hoisting engine			0	Several		Obstruction in pipes
Sept. 1	Bushton, Kansas			Oxygen tank			0	1		
Sept. 1	Cincinnati, Ohio	L. Eid Const. Co.	8:00 a.m.	Return-tubular	100	42″ x 12′	1	2	$1250	Defective safety valve and steam gage
Sept. 3	Atlanta, Ga.	Rice & Montjoy's Garage	7:20 a.m.	Water-tube	93		0	0	$25	Stop-valve ruptured
Sept. 5	Hanover, Tex.	Hugh Bros. Gin	7:30 p.m.	Water-tube	175	600 hp.	0	2	None	Tube ruptured
Sept. 7	Easton, Pa.	Thomas Iron Co.		Water-tube			1	1		Tubes ruptured
Sept. 7	Birmingham, Ala.	Birmingham Ry., Light & Power Co.	6:00 a.m.	Cross drum water-tube	150	250 hp.	0	0	$300	Tube ruptured
Sept. 7	Charleston, S. C.	Charleston Consol. Rw. & Lighting Co.	3:00 p.m.	Hot-water			0	3	$225	Closing of valves b stake
Sept. 8	Cape May, N. J.	Cape May Light & Power Co.		Cast-iron heating			0	0		Seven sections fractured
Sept. 8	Portchester, N. Y.	Turkish Baths								
Sept. 9	Buffalo, N. Y.	Central Casket Co.								

BOILER EXPLOSIONS DURING SECOND HALF OF 1914—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Sept. 9	Rome, Ohio	Oscar Stout's					0	3		
Sept. 10	Worcester, Mass.	Warren Hotel		Cast-iron heating			0	0		Section cracked
Sept. 10	Pelham, Ga.	Pelham Manufacturing Co. Cotton Mill					1	0		Blow-off pipe ruptured
Sept. 11	Welch, Okla.	Geo. Davis	6:00 p.m.	Traction thresher			1	1		Over pressure
Sept. 12	Waukegan, Ill.	American Steel & Wire Co.		Water-tube			0	0		Tube ruptured
Sept. 14	Norfolk, Va.	Southern Ry. Power Plant	11:00 p.m.	Marine type	120	150 hp.	2	0	$1000	Unknown
Sept. 15	Piper City, Ill.			Portable			0	1		
Sept. 15	Near Mobile, Ala.	Mexican Gulf Oil Co's Tug "Gertrude"					Several	0		
Sept. 16	Pawtucket, R. I.	American Yarn Manufacturing Co.	3:00 p.m.	Return-tubular	95		0	0	$100	Cracks developed along line of rivet holes
Sept. 16	Rochester, N. Y.	Flower City Tissue Mills					0	0		
Sept. 18	St. Mary's, W. Va.			Traction well drill			0	2		Old boiler
Sept. 22	Kincardino, Ont., Can.			Threshing engine	100	15 hp.	1	2	$300	Defective
Sept. 22	Covington, Ga.	A. Wilson Sawmill		Locomotive type	45	20 hp.	1	2	$100	Worn out (over 40 yr. old)
Sept. 22	East Chicago, Ill.	Republic Iron & Steel Co.		Water-tube			0	1		Tube ruptured
Sept. 22	Vernon, Mich.			Threshing machine			0	1		
Sept. 22	Shamokin, Penn.	Mahon-Kearney Bldg.					0	1		Section failed
Sept. 23	Savannah, Ga.	National Restaurant					0	0	$800	
Sept. 24	Fremont, Ind.	J. W. Goodwin's Sawmill	5:30 p.m.	Horizontal-tubular	115	60 hp.	0	0	$2.50	Blow-off failed
Sept. 24	Windber, Penn.	Berwind-White Mining Co.		Water-tube			0	0		Two tubes ruptured
Sept. 24	Conneaut, Ohio	Car Ferry "Bessemer No. 2"		Scotch marine	150		2	1		Pipe leading to steam chest ruptured
Sept. 25	Des Moines, Ia.	Highland Park College	9:30 p.m.	Return-tubular		60" x 18'	0	1		Blow-off pipe elbow broke
Sept. 25	Bowling Green, Ky.	Troy Steam Laundry					0	0		
Sept. 26	Victoria, Tex.	Texas Southern Electric Co.		Water-tube			0	0		Tube ruptured
Sept. 26	Livingston, S. I., N. Y.	Richmond Light & Ry. Co.	1:45 p.m.	Water-tube	200		0	2		Tubes failed in 3 boilers
Sept. 27	Bel Air, Md.	J. W. Archer & Sons Creamery	1:00 p.m.	Vertical-tubular	80	25 hp.	0	1	$200	Fire box blew out
Sept. 28	Storrs, Utah	Spring Canyon Coal Co.	8:00 a.m.	Scotch marine	150	150 hp.	2	5	$20,000	Furnace failed
Sept. 29	Atlantic City, N. J.	Freihofer's Bakery	9:00 p.m.	Vertical	40	40 hp.	1	0	$300	Stay bolts corroded
Oct. 1	Waterbury, Conn.	Scoville Manufacturing Co.		Water-tube			0	0		Tube ruptured
Oct. 2	Bunkie, La.	Bunkie Compress & Warehouse Co.		Water-tube	110	150 hp.	0	1	$25	Tube ruptured
Oct. 3	Elmendorf, Tex.	Sacuger Ginning Co.		Return-tubular	100	40 hp.	0	1		Blow-off pipe failed
Oct. 3	New Salem, N. Y.			Large portable			0	1		
Oct. 4	Kansas City, Mo.	G. A. Fletcher Home		Cast-iron heating			0	2		Section cracked
Oct. 5	New Brunswick, N. J.	E. H. Wikoff Home		Cast-iron heating			0	0	$2000	
Oct. 7	Niagara Falls, N. Y.	Hooker Electrochemical Co.		Water-tube	120	200 hp.	0	0	$500	Tube ruptured
Oct. 8	Robertsdale, Penn.	Rock Hill Coal & Iron Co.	6:45 a.m.	Return-tubular	100	125 hp.	1	5	$6000	Defective safety valve
Oct. 9	Canton, Miss.	Canton Oil Mill Co.		Return-tubular	80		0	1		Blow-off pipe failed
Oct. 10	Kansas City, Mo.	Kansas City Electric Light Co.		Water-tube	175	509 hp.	0	3	None	Tube ruptured
Oct. 12	Beatrice, Neb.	Ford Asphalt Co.					1	3		
Oct. 13	Battle Creek, Mich.	Grand Trunk Freight House	12 M.	Heating			0	2		
Oct. 13	Creswell, Md.	Fred Smith's Cannery.	4:00 p.m.	Vertical fire tube	50	40 hp.	0	0	$400	Fire box failure
Oct. 14	Rodbourn, Ky.	M. J. Dillon's Sawmill	9:00 a.m.				3	2		
Oct. 14	Lordsburg, N. M.	Lordsburg Water, Ice & Electric Co.	7:00 p.m.	Water-tube	140	100 hp.	0	0	$91	Cast-iron header failed
Oct. 14	Lordsburg, N. M.	Lordsburg Water, Ice & Electric Co.		Water-tube	140	100 hp.	0	0		Tube ruptured. Second accident same day
Oct. 14	Kansas City, Mo.	Loose-Wiles Biscuit Co.	10:30 a.m.	Water-tube	160	250 hp.	0	1		Tube ruptured
Oct. 15	Sylvania, Ala.	Cotton Gin & Grist Mill					2	Several		
Oct. 16	Long Island City, N. Y.	Astoria Land & Improvement Co.		Return-tubular	70	60" x 16'	0	0	Small	Rupture of fire sheet
Oct. 19	Kanopolis, Kan.	District No. 4 Schoolhouse		Cast-iron heating			0	0	$59	Section cracked
Oct. 20	Pauls Valley, Okla.	Washita Electric Power Co.	5:30 p.m.	Exhaust steam heater	125		0	0	$50	Excessive pressure
Oct. 20	Osage, Ia.	August Holtman Farm		Threshing engine	125	16 hp.	0	0	Engine only	Stay bolt rusted
Oct. 20	Ilion, N. Y.	Harry Eckler Home	10:30 p.m.	Hot-water tank	110	30 gal.	0	1	$5750	No safety valve
Oct. 20	Terre Haute, Ind.	Terre Haute, Indianapolis & Eastern Traction Co.	2:30 p.m.	Water-tube	160	520 hp.	0	0	None	Cast-iron header cracked
Oct. 22	Boston, Mass.	Louville V. Niles Apartment House		Cast-iron heating			0	0		Section ruptured
Oct. 23	New York City	Horn & Hardart Co. Restaurant		Cast-iron heating			0	0		Three sections ruptured
Oct. 23	Battle Creek, Mich.	Kellogg Toasted Corn Flakes Co.	3:00 a.m.	Vertical water-tube	150	200 hp.	0	0	None	Low water
Oct. 24	Starkville, Miss.	Munic. Elec. Light & Water Plant		Water-tube			0	0		Headers and tube ruptured
Oct. 26	Watts, Okla.	Sawmill	10:00 a.m.	Locomotive type	95	25 hp.	1	3	$200	Low water
Oct. 26	Oubre, La.	L. Wagnespack Bros. Sugarhouse		Water-tube			0	0		Tube ruptured
Oct. 27	Babbitt, N. J.	B. T. Babbitt		Steam separator			1	2		Cover burst
Oct. 27	New York, N. Y.	Continental Hotel	9:15 p.m.	Scotch marine	125	250 hp.	2	2		Rear tube sheet bulged
Oct. 27	Chicago, Ill.	Costello Bros. Undertaking rooms		Heating			1	4		New boiler fired first time
Oct. 29	New York City	Alexander Konta Home		Hot-water heating			0	0		Section ruptured
Oct. 29	Harmony Junction, Penn.	Pittsburgh, Harmony, Butler & New Castle Rw. Co.		Water-tube			0	1		Tube ruptured
Nov. 1	Garwood, N. J.	Garwood Mfg. Co.		Cast-iron heating	1		0	0		Three sections ruptured
Nov. 1	Itasca, Ill.	Willand Dairy Co.	8:30 a.m.	Horizontal	100	60 hp.	0	0	$200	Bagged boiler
Nov. 2	Grand Rapids, Mich.	Belknap Wagon Co.		Steam radiator	50		0	1		Unknown
Nov. 2	Boston, Mass.	Charlesbank Homes	2:30 p.m.	Cast-iron heating	3	6 Sections	0	0	$128	Two sections ruptured
Nov. 3	Bond, Miss.	Bond Lumber Co.	1:30 p.m.	Horizontal-tubular	100	60" x 18'	0	1		Blow-off pipe failed
Nov. 3	Olmstead, W. Va.	Houston Collieries Co.	9:30 p.m.	Tubular	90	72 Tubes	1	0	None	Blow-off pipe failed
Nov. 3	Storrs, Utah	Spring Canon Coal Co.	7:45 a.m.	Scotch marine	150	150 hp.	2	4	$15,000	Collapsed flue sheet
Nov. 4	Des Moines, Ia.	City Ice Co.	3:00 a.m.	Return-tubular	100	72" x 18'	0	0	$60	Accumulation at rear of boiler
Nov. 5	Selinsgrove, Penn.	Joseph Ramer's Farm	12 M.	Locomotive type	100	10 hp.	2	4		Over pressure
Nov. 7	Munday, Tex.	Cobb & Furguson, Cotton gin		Tubular	90	60" x 14'	0	0		Unknown
Nov. 8	Toledo, O.	Woolson Spice Co.		Cast-iron heating			0	0		Manifolds ruptured
Nov. 9	Moosehead Lake, Me.	Steamer "Twilight"					1	0		Blow-off failed
Nov. 9	Granby, Mo.	American Beauty Mine	8:00 a.m.	Fire-tube	60	35 hp.	1	1		Old and thin
Nov. 10	New York, N. Y.	Interborough R. T. Co.		Water-tube	215	520 hp.	0	2		Tube ruptured
Nov. 10	Manayunk, (Phila.) Penn.	R. Hamson Home		Cast-iron heating			1	0		Sections failed

BOILER EXPLOSIONS DURING SECOND HALF OF 1914—Continued

Nov. 10	Manayunk, (Phila.) Penn.	R. Hamson Home		Cast-iron heating						

POILER EXPLOSIONS DURING SECOND HALF OF 1914—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Nov. 11	Eureka, Kan.	Eureka Light & Power Co.	6:30 p.m.	Water-tube	120		1	0		Sections failed
Nov. 11	Reading, Penn.	Round House				150 hp.	0	0		Tube failed
Nov. 14	Pittsburgh, Penn.	Penny Chocolate Co.					0	1		Steam pipe burst
Nov. 16	Garner, Ark.	T. W. Sloan's Cotton Gin & Sawmill	1:30 p.m.			40 hp.	2	0	$1000	Low water
Nov. 16	Boonville, Ind.	H. C. Christ, Bakery	2:00 a.m.	Single-tube	70	50 gal.	0	1	$100	Low water
Nov. 16	Baltimore, Md.	Thomas Horst's Bakery	1:00 p.m.				0	1		
Nov. 16	Wilmington, Del.	Wilmington & Phila. Tract. Co.		Water-tube			0	1		Tube ruptured
Nov. 16	Aberdeen, S. D.	H. J. Lockington Packing House					0	0		Furnace flue collapsed
Nov. 18	Plymouth, Mich.	High School		Cast-iron heating			0	0		Return pipe of heating system failed
Nov. 18	Monroe, La.	Monroe Shingle Co.	6:30 a.m.	Return-tubular	100		2	1		
Nov. 19	So. Portland, Me.	Bancroft & Martin Rolling Mills Co.		Water-tube			0	0		Mud drum head fractured
Nov. 20	Columbia, Tenn.	Tennessee Orphans Home		Water back of stove			0	0	Small	Pipes frozen
Nov. 21	Upper Sandusky, O.	E. G. Blaser, Tile Factory		Tubular	100		0	0		Bagged patch leaked
Nov. 21	Coal Creek, Wash.	Inman-Poulsen Lumber Co.		Donkey engine			2	0		
Nov. 21	Philadelphia, Penn.	Joseph Deni	5:00 p.m.	Cast-iron heating	5		0	0	$300	Defect in a cap
Nov. 21	Cartersville, Ga.	Police Headquarters					0	0		
Nov. 22	Orient, Ia.	Public School Bldg.	4:30 p.m.	Cast-iron heating			0	0	$250	Low water, cold water admitted
Nov. 23	So. Boston, Mass.	Geo. A. Hill Co. Fact.		Cast-iron heating			0	0		Four sections ruptured
Nov. 23	Cincinnati, O.	A. S. Taft Bldg.					0	0		Blow-off pipe failed
Nov. 23	Sioux City, Ia.	Sioux City Traction Co.		Cross drum water-tube	150	4140 sq.ft.	0	0		Tube failure using muddy water. Tube plugged, overheated and pulled out
Nov. 23	Richmond, Ind.	City Hall		Cast-iron heating	5		0	0		Over pressure (60 lb.)
Nov. 23	Brooklyn, N. Y.	Brooklyn Rapid Transit Co.		Water-tube			0	1		Tube failure
Nov. 24	Milford, Mass.	Smith's Block		Cast-iron heating			0	0		Low water
Nov. 26	So. Liberty, Mo.	City of Liberty Water Works		Fire tube	126	54″ x 14′	0	0	$25	Blow-off pipe failed
Nov. 26	Green Hill, Penn.	Edward H. Jacob Home	9:00 a.m.	Cast-iron heating, hot-water	Head	No. 25-5	0	0	$800	All valves closed by mistake
Nov. 27	St. Louis, Mo.	St. Louis Hide & Tallow Co.		Rendering tank			0	2		
Nov. 27	Harmony (Junction), Penn.	Pitts. Harmony Butler & N. Castle Ry.	2:45 p.m.	Water-tube			0	5		Tube ruptured
Nov. 28	Hodges, S. C.	Portable Schredder	10:00 a.m.	Locomotive type	175	13 hp.	3	2	$500	High pressure. No relief valve
Nov. 29	Brockton, Mass.	Brockton Nat. Bank	5:00 p.m.	Cast-iron heating boiler	15		0	0		Three sections ruptured
Nov. 30	Chicago, Ill.	House 719 So. Ashland Boulevard		Heater			1	0		
Dec. 1	Yonkers, N. Y.	Federal Sugar Ref. Co.		Economizer			0	0		Cast-iron header ruptured
Dec. 1	West Butler, Pa.	State Police Barracks		Cast-iron heating			0	0		
Dec. 1	Troy, N. Y.	Knowlson & Kelly		Vertical-tubular	90	42″ x 8′	0	0		Unknown
Dec. 1	Vineland, N. J.	Chas. Keighley & Sons					1	0		
Dec. 2	Chicago, Ill.	Mrs. Mary Bottigher's Home		Cast-iron hot water heater			1	0		
Dec. 2	Erie, Penn.	H. F. Watson					1	0		Steam pipe burst
Dec. 2	Pinewood, S. C.	A. R. Rollings Sawmill	10:00 a.m.	Return-tubular	125	40 hp.	0	4	$1500	Low water
Dec. 3	Waltham, Mass.	McGregor Garage		Air tank			0	0		
Dec. 4	Boston, Mass.	Boston Edison Co.	4:30 p.m.	Water-tube	200	512 hp.	0	3	$8.50	Defective tube
Dec. 4	Carthage, Mo.	Atlas Mine					0	8		
Dec. 5	Van Wert, O.	Van Wert Light Co.					0	0		
Dec. 5	Mexia, Tex.	Munger Oil and Cotton Co.					0	0		
Dec. 6	Stoutsville, O.	Gem Coal Co.					0	0		
Dec. 7	Omaha, Neb.	Omaha El. Lt. & Pr. Co.					0	0		Blow-off pipe failed
Dec. 7	N. Y. City, N. Y.	No. 161 Mulberry St.	11:30 a.m.	Water-tube	80	75 hp.	0	1		Mud drum ruptured
Dec. 9	Millville, N. J.	N. C. Down's Milk Pasteurizing Plant					0	0	$750	
Dec. 9	Ellenboro, W. Va.	Gas Pumping Plant					0	0	$2000	
Dec. 9	Des Moines, Ia.	Wellington Hotel					0	0		
Dec. 10	Maspeth, L. I., N. Y.	Adlers Monument & Granite Works		Water-tube			0	0		Three cast-iron headers ruptured
Dec. 10	Rockwood, Tenn.	Roane Iron Co.	12:45 p.m.	Return-tubular	80	46″ x 32′	1	1	$2500	Low water (2 boilers exploded)
Dec. 10	Des Moines, Ia.	Y. W. C. A.	12 M.	Round cast-iron heater	15	2′x3′	1	0		Outlet and return feed line valves closed
Dec. 11	Near Winfield, Ark.	W. G. Lassiters Sawmill					2	3		
Dec. 11	Carlinville, Ill.	Blackburn School					0	0		
Dec. 12	Boston, Mass.	Hotel Buckminster					0	0		Blow-off pipe ruptured
Dec. 14	Wellsberg, W. Va.	Eagle Glass Mfg. Co.		Cast-iron heating			0	0		Five sections ruptured
Dec. 14	Detroit, Mich.	Oscar Rosenberger's Auto-Show Room		Cast-iron heating			0	0		One section ruptured
Dec. 14	Oakland, Ill.	Dist. No. 2 Schoolhouse		Cast-iron heating			0	0		Sections ruptured in 2 boilers
Dec. 14	St. Louis, Mo.	3739 Windsor Place		Cast-iron heating			0	1		Section failed
Dec. 15	Canton, Ill.	Scripps Dry Goods Co.	3:00 p.m.	Cast-iron heating	7	5 Sections	0	0		Unknown
Dec. 15	Decatur, Ill.	Decatur Ry. & Lt. Plant	10:55 a.m.		150		0	0	$200	Main steam line failed
Dec. 15	Akron, O.	N. Fried Home	10:00 a.m.	Hot-water			0	1	$500	Frozen pipes
Dec. 15	Bloomsburg, Penn.	Paul E. Wirt Home		Hot-water heating			0	0	$3000	
Dec. 15	Jessup, Penn.	Dr. Larajay's House					0	1		
Dec. 15	Memphis, Tenn.	Ed. G. Willington Spoke Factory					0	1		Blow-off pipe failed
Dec. 15	San Antonio, Tex.	Arthur Hotel		Cast-iron heating			0	0		
Dec. 16	Coldwater, Mich.	Fortnightly Musical Club		Cast-iron heating			0	0		Section cracked
Dec. 16	Scranton, Penn.	305 No. Washington Ave.					1	0		Pipe burst
Dec. 16	Leavenworth, Kans.	First Methodist Church		Cast-iron heating	5	S-48-7	0	0	$440	Low water; water admitted
Dec. 17	Baltimore, Md.	Independent Ice Co.					0	0		Stop valve on steam line failed
Dec. 17	Quincy, Ill.	Mrs. Eliz. Freiberg Home	3:30 p.m.	Cast-iron heating			0	0		Water frozen. Fire started
Dec. 17	Jefferson City, Mo.	Meuller Bros. Bakery		Cast-iron heating	10	5 Sections	0	0		No water
Dec. 17	Meridian, Miss.	Acme Building Supply Co.	6:00 p.m.	Horizontal-tubular	125	60″ x 18′	0	2	$5	Blow-off pipe failed
Dec. 17	Grand Rapids, Mich.	Rainville Leather & Belting Co.		Vertical water-tube	140	200 hp.	1	0	$150	Blow-off pipe ruptured
Dec. 17	Bellefontaine, O.	Harry Hipple's Home		Heating			0	1		
Dec. 17	Montgomery, Ala.	Thompson Hotel		Cast-iron heating			0	0		
Dec. 18	Ware, Mass.	Chas. A. Stevens Woolen Mill					0	1		
Dec. 20	New York City	Horn & Hardart Rest. Co.		Cast-iron heating	10		0	0		Two sections cracked
Dec. 20	Pittsburg, Pa.	First Nat. Bank		Cast-iron heating			0	0		Eleven sections cracked

BOILER EXPLOSIONS DURING SECOND HALF OF 1914—Continued

Date	Place	Plant	Time of Day	Kind of Boiler	Pressure Carried, Lb.	Size	Killed	Injured	Property Loss	Probable Cause
Dec. 21	Greenfield, Ia.	County Court House	11:00 a.m.	Heating	10		0	0		
Dec. 21	Highlandtown, Baltimore, Md.	Bay View Asylum		Water-tube			0	1		Tube ruptured
Dec. 21	Wollaston, Mass.	Mrs. R. O. Jefferson Home		Kitchen stove			0	1		
Dec. 21	Parkers Prairie, Minn.	Friske's Blacksmith Shop	5:00 p.m.	Vertical fire-tube	35	20 x 50 in.	0	1	$105	Frozen and burst
Dec. 21	Akron, O.	Spicer School Bldg.					0	0	Considerable	
Dec. 21	Hawley, Penn.	Hawley Inn					0	0		Section failed
Dec. 21	Atlanta, Ga.	J. Hunnicutt's Home		Cast-iron heating			0	0		Section ruptured
Dec. 22	Braintree, Mass.	Masonic Temple		Cast-iron heating	155	500 hp.	0	1		Bad tube, header blew out
Dec. 22	New York Mills, N. Y.	New York Mills		Water-tube			0	0		Three sections ruptured
Dec. 23	Wellsburg, W. Va.	Eagle Glass Mfg. Co.		Cast-iron heating			0	0		Three sections ruptured
Dec. 25	Hartford, Conn.	Fourth Congregational Church		Cast-iron heating			0	0		
Dec. 26	Gettysburg, Penn.	Eagle Hotel		Cast-iron heating			0	0		
Dec. 26	Philadelphia, Penn.	Mrs. Rachell Howell Home		Kitchen range			0	3		
Dec. 27	Washington, D. C.	House 2226 I. St.	8:00 a.m.	Waterback of stove			0	3	$60	Water off
Dec. 27	Oakland, Calif.	1836 Hortens Ave.		Cast-iron heating			0	3		Section burst
Dec. 27	Wilmington, Del.	Cookman M. E. Church	9:30 a.m.	Water-tube in section	20		0	0	$10	Tube burst
Dec. 27	Philadelphia, Penn.	Falls of Schuylkill M. E. Church		Cast-iron heating			0	0	$300	Worn out
Dec. 27	Tamaqua, Penn.	P. R. R. Restaurant	6:30 a.m.	Water back in stove			0	0		Pipes frozen
Dec. 28	Matawan Station, N. J.	Matawan Tile Co.					0	1		Steam pipe failed
Dec. 28	Renovo, Penn.	F. Altier's Home		Kitchen water tank			0	1		
Dec. 28	Philadelphia, Penn.	H. B. Pancoast & Co.		Cast-iron heating			0	3		Pipes frozen
Dec. 28	Norfolk Downs, Mass.	Boston Gear Works		Hot-water heater			0	1		
Dec. 29	Pittsburg, Penn.	Duquesne Light Co.		Water-tube			0	2		Tube ruptured
Dec. 31	Clinton, Ia.	Clinton Sugar Ref. Co.		Water-tube			0	0		Cast-iron cross connection ruptured
Dec. 31	Dayton, O.	Philip Jergen's Butcher Shop	12 M.	Vertical-tubular	150		0	1	$1000	

Totals:—Failures, 255; killed, 80; injured, 217; reports of property loss, 73; property loss, $36,000; tube failures, 38; cast-iron header failures, 8; blowoff pipe failures, 18; domestic boiler failures, 65; portable boiler failures, 17

A. I. E. E. Convention

With a relatively small attendance but an excellent opportunity for the members to become better acquainted and benefit by an exchange of ideas, the annual convention of the American Institute of Electrical Engineers was held at Deer Park, Md., June 29 to July 2. A variety of professional papers was presented and covered the diversified interests of the Institute.

The address of President Lincoln on Tuesday morning dealt with the advances in electricity and power production with special reference to increased efficiency. Quoting from the address of Past-President Kennelly in 1898, he pointed out that the margin of improvement is gradually decreasing as the theoretical limitations are approached, and that future advances must be relatively smaller unless some entirely new fields are exploited.

"The Electric Strength of Air" was the title of the first technical paper, by Prof. J. B. Whitehead, who explained in

PRESIDENT-ELECT J. J. CARTY

simple language the theory of ionization in gases as relating to the formation of coronas. The paper was discussed by F. W. Peek, P. H. Thomas, E. F. Creighton and Harris J. Ryan; the last pointing out that the higher the frequency, the less the voltage required to break down the gap.

The next paper was by J. F. H. Douglas, on "The Reluctance of Some Irregular Magnetic Fields," in which the field of an electric generator was analyzed and made to depend upon the reluctance of two dimensional magnetic fields. The reluctance of these fields was determined by experiments made on sheets of high-resistance metal and by mathematical computations, the results being expressed in the form of charts and formulas. Plates were included, showing the shape of the magnetic lines of force in different parts of electrical machines.

Following this was a paper in three parts, on "Irregular Wave Forms," which was presented by Professor Bedell. Part I, representing the work of Professor Bedell, R. Bown and H. A. Pidgeon, dealt with "Form Factor and Its Significance"; the second part, in which the author was assisted by Mr. Bown and C. L. Swisher, took up "Distortion Factors"; and the third part, the work of F. M. Mizushi, was on "An Analytical

and Graphical Solution for Nonsinusoidal Alternating Currents."

In the afternoon a symposium on foundations for transmission-line towers, by J. A. Walls, J. B. Leeper, W. E. Mitchell, P. M. Downing and F. C. Connery, was discussed. This was followed by a brief outline on "Fields of Motor Application," by D. B. Rushmore. A number of written discussions, each dealing with a special field of application, were read. H. E. Stafford next read a paper on "Electricity in Grain Elevators."

The president's reception took place on Tuesday evening and was followed by a dance.

The program for Wednesday morning included two papers: "The Classification of Alternating-Current Motors," by Val. A. Flynn, and "The Classification of Electromagnetic Machinery," by Frederick Creedy. With the object of making it easier to correctly represent, describe and classify alternating-current motors, Mr. Flynn offered descriptive names and conventional diagrams for 44 types. He further pointed out that the term "repulsion," as applied to present motors, is a misnomer, as no practical motors operate on what has been known as the repulsion principle. Mr. Creedy proposed to classify dynamo-electric machinery according to five sets of characteristics as follows: (1) Type of field-constant intensity, variable intensity, multiple polarity and homopolar; (2) method of disposal of secondary power; (3) use of commutators; (4) method of magnetization—high-frequency magnetization as in the induction motor and low-frequency magnetization as in the synchronous and compensated motors; (5) method of connection.

On Wednesday evening President-Elect J. J. Carty (chief engineer of the American Telephone & Telegraph Co.) was introduced and in a short address eulogized the work of President Lincoln, promising to carry on a number of plans inaugurated by the latter, especially the attempt to improve the status of the engineer outside the profession.

Honorary Vice-President Harris J. Ryan was next called upon and responded with greetings from the Pacific Coast. He called attention to the former isolation of that section, which had now been completely overcome by the Panama Canal and by the transcontinental telephone, both products of engineering skill. Following the usual custom, the past-president's badge, or pin, was presented to President Lincoln on behalf of the Institute by Farley Osgood.

The remainder of the evening was devoted to a joint session with the Illuminating Engineering Society, at which a most interesting paper was delivered by Preston S. Millar, on "The Effective Illumination of Streets." Besides being illustrated by slides, the talk was enlivened by a model of a street with miniature lights that could be switched on and off to give any desired combination.

Thursday morning was devoted to the railway session, at which the following papers were read: "Construction and Maintenance Costs of Overhead Contact Systems, Part I," by E. J. Amberg, Part II, by Ferdinand Zogbaum; "Contact System of the Butte, Anaconda & Pacific Ry.," by J. B. Cox; "Third-Rail and Trolley System of the West Jersey & Seashore Railroad," by J. V. B. Duerr; "Unprotected Top-Contact Rail for 600-Volt Traction System," by Charles H. Jones; "Contact Conductors and Collectors for Electric Railways," by C. J. Hixson; and "Contact System of the Southern Pacific Co.—Portland Division," by Paul Lebenbaum.

Friday's program consisted of the following papers: "Phase Angle of Current Transformers," by Chester L. Dawes; "Instrument Transformers," by Charles L. Fortescue; "The Induction Watt-Hour Meter," by V. L. Hollister; "The Measurement of Dialectric Losses with the Cathode Ray Tube," by J. P. Minton; "Economic Operation of Electric Ovens," by P. W. Gumaer; and "Class Rates for Electric Light and Power Systems or Territories," by F. G. Baum. In the last paper the author favored the establishment of uniform rates throughout a system or territory for different classes of service. He segregated the services into eight different classes and divided the rates into energy and demand charges.

The entertainment features of the convention included golf and tennis tournaments, a swimming contest, a card party for the ladies, and dancing—the hotel and grounds affording exceptional facilities for such diversion.

Michigan N. A. S. E. Convention

From June 23 to 25 the Michigan Association of the National Association of Stationary Engineers held its eleventh annual convention at Jackson, Mich. Headquarters was at the Otsego Hotel and the convention was held in the A. U. V. Auditorium. About 30 delegates were registered, but over one hundred engineers attended from Jackson and other cities in the state. The first session was called to order Wednesday afternoon by F. W. Brandau, chairman of the Convention Committee. Mayor William Sparks gave the address of welcome, and C. W. Naylor, past-national president, responded. Paul A. Leidy, secretary of the Jackson Chamber of Commerce, then addressed the convention, and was followed by Charles Wirmel, who spoke of the work of the National License Committee. In behalf of the Central States Exhibitors' Association, President Charles Cullen extended to the public as well as to all engineers in the city an urgent invitation to visit the exhibits. John Andrews, state president, was then presented and officially opened the convention. In the evening an informal reception was held in the exhibit hall.

Thursday morning the engineers visited the plant of the Commonwealth Power Co. and the Michigan State Prison. In the afternoon a special car carried the conventioners to Hague Park, where field sports and the usual ball game between the engineers and exhibitors were the features of the entertainment. In the tug-of-war the engineers proved that they had more brawn and muscle than the exhibitors, but the latter won the honors in the ball game by the close score of 11 to 10. The contest was exciting, but peace was preserved by Messrs. Raven and Hickey, who, in their capacities as umpires, were strictly neutral. In the evening a banquet was held in the exhibit hall. F. W. Raven, acting as toastmaster, kept the diners in a happy frame of mind.

STATE N. A. S. E. DELEGATES AND FRIENDS GATHERED AT JACKSON, MICH.

Friday was devoted principally to business. Kalamazoo was chosen as the next convention city and the following officers were elected for the ensuing year: Fred Tesch, president; John P. Brown, vice-president; E. C. Smith, secretary; H. F. Bagley, treasurer; E. W. Messanny, conductor; George A. Turnbull, doorkeeper; William Yeomans, state deputy.

At a meeting of the exhibitors the following officers were nominated: Charles H. Fiske, president; H. W. McKinley, secretary-treasurer; Charles Cullen, Thomas N. Bishop, J. L. Gifford, M. F. Thompson, A. R. Maujer, S. F. Denny, R. B. Osgood, Executive Committee. These officers will be voted upon at the Wisconsin State Convention to be held at Sheboygan, July 22-24. R. A. Cross was elected vice-president for the State of Michigan.

The following firms exhibited:

American Oil Co.
Anchor Packing Co.
Anderson, Kenneth
Anderson Co., The V. D.
Arrow Boiler Compound Co.
Buckeye Chemical Co.
Central Distributing Co.
Crandall Packing Co.
Crane Co.
Dearborn Chemical Co.
Edward Valve & Manufacturing Co., The
Garlock Packing Co.
Grand Rapids Supply Co.
Greene, Tweed & Co.
Hawkeye Compound Co.
Home Rubber Co.
Jenkins Bros.
Johns-Manville Co., H. W.
Keystone Lubricating Co.
Lagonda Manufacturing Co.
Lunkenheimer Co.
Murray Sales Co., W.
"National Engineer"
Peerless Rubber Manufacturing Co.
Powell Co., The William
"Power"
Powers Rubber Works
Quaker City Hardware Co.
Standard Oil Co.
Smith-Winchester Hardware Co
Starr Hardware Co.
Valvoline Oil Co.

New York's Refrigeration Ordinance

With the aid of a committee of the American Society of Refrigeration Engineers the Fire Prevention Bureau has drawn up the following rules which are embodied in an existing ordinance. The rules are now in effect.

Section 216. Permits—Except as hereinafter provided in this article, it shall be unlawful to operate within the city any plant producing refrigeration by means of gases under pressure in connection with cold-storage plants, breweries, ice manufactories, hotels, restaurants or other places, without a permit.

Sec. 217. Refrigerating Plants—1. Construction. Each refrigerating plant shall be equipped with an emergency pipe or pipes by which, in case of accident, the gas under pressure can be discharged by a valve which can be opened both inside and outside the refrigerating plant into water, or brought into contact with sufficient water to absorb and carry off all gases so discharged. At the discretion of the fire commissioner the emergency pipe or pipes may conduct the gases to a point at least 10 ft. above the roofs of adjacent buildings into the open air.

2. Safety Devices—All refrigerating machines shall be equipped with automatic safety devices, which discharge at 300-lb. pressure to the square inch for ammonia, 1400-lb. pressure to the square inch for carbon dioxide, 100-lb. pressure to the square inch for sulphur dioxide, and 100-lb. pressure to the square inch for ethyl chloride into the emergency pipes required by the preceding section or into the low-pressure side.

3. Exits—In refrigerating plants built and erected after July 1, 1915, every room containing pipes carrying a refrigerating chemical under pressure exceeding 40 lb. per square inch for ethyl chloride, 60 lb. for sulphur dioxide, 100 lb. for ammonia and 500 lb. for carbon dioxide, and which by accident may become filled with the gases generated by said chemicals, shall have an exit to the open air direct or by means of stairway or to a room or hall from which said gases can be excluded. Other refrigerating plants shall be provided with such means of exit as the fire commissioner may prescribe. Rooms which contain only the liquid supply pipe to the refrigerator coils are not included within the meaning of this section.

Sec. 218. Pressure—The maximum pressure allowed in refrigerating machines shall not exceed 300 lb. for ammonia, 1400 lb. for carbon dioxide, 100 lb. for sulphur dioxide and 100 lb. for ethyl chloride to the square inch. All pipes used for refrigerating purposes shall stand a hydrostatic test of at least double the maximum pressure per square inch specified in this section. All fittings must be guaranteed to stand a pressure of at least three times the maximum pressure per square inch specified in this chapter.

No. 219. Lights—No room containing refrigerating condensers or compressors of ammonia or ethyl chloride under pressure shall have in it any open flame, arc light or direct opening into the boiler room; but an internal combustion engine may be located therein, which may be started in the usual manner. There shall be a fire-wall between such room and the boiler room, equipped with a self-closing door.

Sec. 220. Precautions—1. Helmets or respirators. In such large refrigerating plants as may be designated by the fire commissioner there shall be kept, fit and available for use, suitable helmets or respirators which shall permit the wearer to reach, without suffocation, any part of the refrigerating system.

2. Pipes to be designated. In all refrigerating plants the pipes in the engine room shall have conspicuous signs displayed at proper places designating in easily legible letters the name of the refrigerating chemical contained therein.

3. Rules—In all refrigerating plants there shall be posted several copies of a brief set of rules satisfactory to the fire commissioner, directing all employees as to their duties in case of fire, or other emergencies. Employers shall be responsible for the proper drill of all employees in such emergency duties.

4. Supervision—No refrigerating machine of over three tons' refrigerating capacity shall be operated unless under the charge of a person holding a certificate of fitness from the fire commissioner.

Sec. 221. Exemptions—1. Surplus storage—Refrigerating plants may store a surplus stock of the refrigerating chemical of two cylinders or, if necessary, a quantity not to exceed 10 per cent. of the charge of the plant. No cylinders containing gas under pressure shall be stored in the boiler room.

2. Refrigerating machines of less than three tons' capacity. The fire commissioner may exempt from the provisions of this article refrigerating machines of less than three tons' refrigerating capacity, provided a certificate of approval has been issued for such machine.

Sec. 222. This ordinance shall take effect immediately.

Adopted by the Board of Aldermen, May 11, 1915.

Received from his Honor the Mayor, May 25, 1915, without his approval or disapproval thereof; therefore, as provided in Section 40 of the Greater New York Charter, the same took effect as if he had approved it.

PERSONALS

L. Jorgensen, formerly with the engineering firm of F. G. Baum & Co., San Francisco, will engage in general electrical and hydraulic-engineering practice, with offices at 1404 Chronicle Building, San Francisco.

H. M. Montgomery, chairman, Chicago Section, American Society of Mechanical Engineers, has been elected vice-president and director of the Powdered Coal Engineering & Equipment Co., of Chicago.

J. E. Ward, engineer of the West Penn Lighting Co., Washington, Penn., recently, in working on a steam pipe, short-circuited a lightning arrester on a 23,000-volt line. The resulting explosion hurled him to the floor, but he escaped with slight burns.

ENGINEERING AFFAIRS

The Ohio Electric Light Association will hold its twenty-first annual convention July 20-23, at the Breakers Hotel, Cedar Point, Ohio. D. L. Gaskill, Greenville, Ohio, is secretary of the association.

The Indiana State Association of the N. A. S. E., at its annual convention elected the following officers for the ensuing year: President, Albert Franke, of Terre Haute; vice-pres., John Lanz, Richmond; treasurer, A. T. Arens, South Bend; secretary, Ignatz Baldus, Indianapolis; conductor, Elza E. Stone, Kokomo; doorkeeper, George Seng, Terre Haute.

International Association for Testing Materials—The seventh congress of the International Association for Testing Materials, scheduled to be held in Petrograd, Aug. 12-17, has been postponed on account of the war. All activities of the association have been suspended because of the disturbed condition in so many of the countries that have contributed to those activities.

TRADE CATALOGS

Morehead Mfg. Co., Detroit, Mich. Catalog No. 11. Tilting steam traps. Illustrated, 64 pp., 6x9 in.

The William Powell Co., Cincinnati, Ohio. Booklet. Powell accessories for oil wells and refineries. Illustrated, 20 pp., 3½x6 in.

The Weber Chimney Co., 332 South Michigan Ave., Chicago, Ill. Catalog No. 10. Reinforced-concrete chimneys. Illustrated, 48 pp., 5x9 in.

Engberg's Electric & Mechanical Works, St. Joseph, Mich. Bulletin No. 101. Direct-connected dynamos and engines. Illustrated, 16 pp., 6x9 in.

American Roller Bearing Co., 416-420 Melwood Ave., Pittsburgh, Penn. Bulletin No. 1002. Roller bearings for power transmission devices. Illustrated, 4 pp., 7x10 in.

National Tube Co., Frick Building, Pittsburgh, Penn. Catalog J. "National" pipe for steam, gas, water and air, "Kewanee" unions and specialties, iron and brass fittings, valves, etc. Illustrated, 394 pp., 5x7½ in.

BUSINESS ITEMS

A 42-in. twin water strainer is being built for the Toledo Railways & Light Co. by the Elliott Co., Pittsburgh. This is one of the largest twin strainers ever built, and is of particular interest because of the motor-drive attachment, by means of which the valves are operated so as to direct the flow of water through either compartment of the strainer. The usual